FLUKE 92B/96B/99B/105B

Service Manual

MP MASTER
MA34974

FLUKE 92B/96B/99B/105B

Service Manual

FLUKE 92B/ 96B/99B/105B

SCOPEMETER® Series II

Service Manual

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FLUKE®

IMPORTANT

In correspondence concerning the ScopeMeter®test tool please give the model number and serial number as located on the type number plate on the instrument.

For your reference:

Model number:	Flukexx
Code number:	9444 yyy yyyyy
Serial number:	DM nn mmmm(m)

Note: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

ScopeMeter is a registered trademark of the Fluke Corporation.

All product names are trademarks of their respective companies.

Warning **These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are fully qualified to do so.**

SERVICE CENTERS

To locate an authorized service center, visit us on the World Wide Web:

http://www.fluke.com

or call Fluke using any of the phone numbers listed below:

+1-800-443-5853 in U.S.A. and Canada

+31-402-678-200 in Europe

+1-425-356-5500 from other countries

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1 SAFETY INSTRUCTIONS

Read this chapter carefully before installation and use of the instrument.

1.1 INTRODUCTION

The following sections contain information, cautions and warnings which must be followed to ensure safe operation and to keep the instrument in a safe condition.

WARNING: Servicing described in this manual is to be done only by qualified service personnel. To avoid electrical shock, do not service the instrument unless you are qualified to do so.

1.2 SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and service personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the instrument.

1.3 CAUTION AND WARNING STATEMENTS

CAUTION: Is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.

WARNING: Calls attention to a potential danger that requires correct procedures or practices in order to prevent personal injury.

1.4 SYMBOLS

Caution (refer to accompanying documents)

Ground symbol

Common input symbol, equipotentiality

Recycling symbol

High BNC input symbol

Static sensitive components (black/yellow)

Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION

High voltage ≥ 400V

1.5 IMPAIRED SAFETY

Whenever it is likely that safety has been impaired, the instrument must be turned off and disconnected from all external voltage sources, and the batteries must be removed. The matter should then be referred to qualified technicians. Safety is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

1.6 GENERAL SAFETY INFORMATION

WARNING: Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to life.

The instrument must be disconnected from all voltage sources and batteries must be removed before it is opened.

Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources and batteries are removed. Components which are important for the safety of the instrument may only be replaced by components obtained through your local FLUKE organization. These components are indicated by an asterisk (*) in the parts list section (chapter 8).

2 CHARACTERISTICS

2.1 INTRODUCTION TO THE FLUKE 92B, 96B, 99B, AND 105B SPECIFICATION

2.1.1 Contents:

2.1 Introduction
2.2 Display
2.3 Scope Mode Signal Acquisition
2.4 Inputs A and B
2.5 Scope Mode Time Base
2.6 Scope Mode Trigger
2.7 Scope Mode Trace Display
2.8 Scope Mode Waveform Math
2.9 Scope Mode Cursors
2.10 Scope Continuous AutoSet
2.11 Input A and EXT mV Multimeter Functions
2.12 Calibration and Signal Generator Outputs
2.13 Set-Up, Waveform, and Screen Memories
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2.15 Power Supply
2.16 Mechanical
2.17 Environmental
2.18 Optical-to-RS232 Interface
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2.21 Service and Maintenance

2.1.2 General

This instrument has been designed and tested in accordance with IEC publication 1010 for Category III instruments. Properties expressed in numerical values are guaranteed by Fluke within the tolerances stated. Numerical values without tolerances are typical and represent the characteristics of an average instrument. The accuracy of all measurements are within ± [%(of reading) ± (one least significant digit)] from 18 °C to 28 °C. Add 0.1 x (Specified accuracy) /°C for < 18 °C or > 28 °C Ambient.

*	Manufacturer	Fluke Corporation
*	Type	Fluke 92B,96B,99B,105B ScopeMeter® Series II family
*	Purpose	Dual Trace Oscilloscope with EXTernal trigger & Multimeter with: Direct Voltage Alternating Voltage EXTernal mV (AC &/or DC) Diode Test Resistance Continuity Test/Beeper

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.2 DISPLAY

* Type	LCD	
* Useful Screen Area	84 mm x 84 mm	1 div equals 25 pixels. 1 div equals 8.75 mm.
Resolution	240 x 240 pixels	
* Contrast ratio		Adjustable via USER OPTIONS or UP/DOWN menus
* Backlight	CCFL	(Cold Cathode Fluorescent Lamp)
* Brightness	50 cd/m2	In high brightness position, externally powered, correct contrast, at least one hour warmed up. Brightness level is adjustable in three steps.

2.3 SCOPE MODE SIGNAL ACQUISITION

* Sampling Type		
@ 1 µs/div...60 s/div	Real Time	
@ 10 ns/div...500 ns/div	Quasi Random	models 92B, 96B
@ 5 ns/div...500 ns/div	Quasi Random	model 99B and 105B
* Maximum Sample Rate	25 MS/s	Sampling Rate depends on time/div setting andis 25 MS/s @ 1 µs/div (and with GLITCH CAPTURE ON).
* Maximum Vertical (voltage) Resolution	8 bits	Over 10 divisions.
* Maximum Horizontal (time) Resolution	25 Samples/div	
* Record Length		
With capture 20 div	512 Samples	
With capture 10 div	256 Samples	
In ScopeRecord® mode	30.000 Samples	
* Acquisition Time (for 20.48 div)		
60 s/div...1 µs/div	20.48 x time/div	Excluding selected trigger delay time.
500 ns/div...10 ns/div	20.48 x time /div	Excluding selected trigger delay time.
500 ns/div... 5 ns/div	20.48 x time /div	Model 99B & 105B Excluding selected trigger delay time. In Quasi Random Mode the acquisition time depends on signal triggers.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Hold-off Time	100 ms or 4 div	Excluding selected trigger delay time.
* Sources	Input A External mV Input Input B	2 Channel Acquisition is in: chopping mode from 60 s/div...50 µs/div alternating mode from 20 µs/div...10 ns/div. Models 99B and 105B 20 µs/div...5 ns/div
* MIN MAX Envelope mode		Grey-Scale envelope record of all changes in the displayed portion of the waveform. The most recent trace is black.

2.4 Inputs A & B

* Signal Input	Insulated BNC	Signal Input BNC common and black banana jack (COM) are connected together.
Common Input	Black Safety Banana Jack	Part of External Trigger/External mV Input.
* Input Impedance		For Frequencies >1 MHz, see Fig. 2.1.
R parallel	1 MΩ ±1%	For DC coupled input. For AC coupled input or GND, add 22 nF in series with R & C parallel.
C parallel	25 pF	

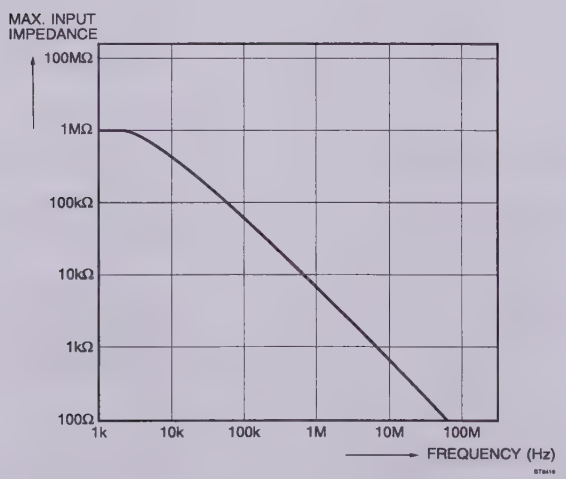


Figure 2.1 Max. Input Impedance Versus Frequency

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Max. Input Capacitance Difference	1.2 pF	Capacitance difference between Input A, Input B, and External Trigger Input.
* Input Coupling	AC DC GND	Sequence: ac, dc, GND (precharge ac); and then back to ac.
* Maximum Input Voltage (rms)	300V	Up to 1 MHz; for frequencies >1 MHz see fig. 2.2. Between BNC inner and outer contact. Outer BNC contacts and Ground (Black) Banana Jack are internally connected together.

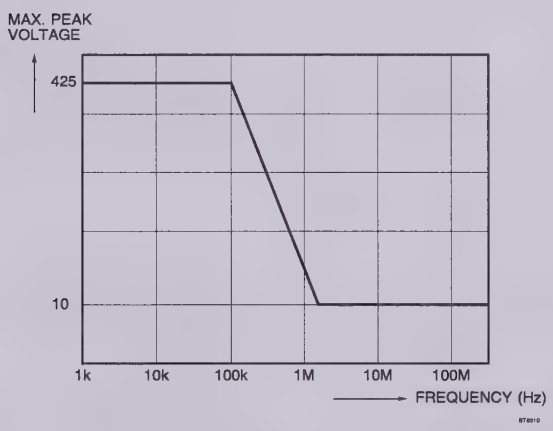


Figure 2.2 Max Input Voltage Versus Frequency

* Deflection Coefficient Steps	1 mV/div...100 V/div	In a 1-2-5 sequence of 14 positions. 1 mV and 2 mV/div only for repetitive signals and timebase 60s...1 µs/div. If one of the input channels is in 1mV or 2 mV/div, both input channels will be switched to average=4.
Error Limit Gain	± (2% ± 1 pixel)	Add 3% for 1 mV/div and 2 mV/div.
Nonlinearity	± (2% ± 1 pixel)	per IEC 351 for frequencies < 1 MHz.
* Dynamic Range	9.5 div 4 div	for frequencies < 10 MHz. for frequencies upto 60 MHz and 100 MHz for model 99B & 105B.
* Position Range (move control)	-4 div...+ 4 div	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Frequency Response.		Z source = 50Ω.
Lower Bandwidth Transition Point		
DC Input Coupling	DC	
AC Input Coupling -3dB	≤ 10 Hz	< 1 Hz with 10:1 probe.
Upper Bandwidth Transition Point		
Models 92B, 96B	≥ 60 MHz (-3 dB)	Subtract 5 MHz for < 18°C and > 28°C over central 6 div.
Models 99B, 105B	≥100 MHz (-3 dB)	Subtract 5 MHz for < 18°C and > 28°C over central 6 div.
* Pulse Response		
Models 92B, 96B		Risetime 5.8 ns, Z Source = 50Ω; measured over central 6 div.
Models 99B, 105B		Risetime 3.5 ns, Z Source = 50Ω; measured over central 6 div.
* Pulse Aberrations		Tested with calibrated 1 ns rise time pulse.
* Pulse Response		
Overshoot & Ringing	Add 4% for input setting AC	
* Max. Base Line Instability Jump	0.2 div or 1 mV	The base line is automatically readjusted after switching the attenuator or AC/DC/GND.
* AVERAGE		Running Average
Maximum Constant	256 x	
Constant in Roll	10 x	
* GLITCH detection		Channel A only.
Time base setting	≥1 µs/div	
Pulse width for 100% probability	40 ns	
Pulse width for 25% probability	10 ns	
* ZOOM		Expansion or compression in 1-2-5 sequence around the 4th division.
Range for delay	< 640 div	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.5 SCOPE MODE TIME BASE

* Modes	Recurrent Single Shot Roll	 Automatic selected
* Ranges		
Recurrent	1 s/div...50 µs/div	Single channel or dual channel chopped.
	20 µs/div...10 ns/div	For models 92B, 96B Single channel or dual channel alternate.
	20 µs/div...5 ns/div	For models 99B, 105B. For alternating every sweep needs a trigger; A sweep first; B sweep arms automatically.
Single Shot	1 s/div...100 ns/div	For 500 ns, 200 ns, and 100 ns; an automatic interpolation takes place.
Roll Mode	60 s/div...2 s/div	Single channel or dual channel chopped.
Maximum Time Base Error	± 0.08% ± 1 LSB	

2.6 SCOPE MODE TRIGGER

* Sources		Selected independently.
Input A Signal	INPUT A	
Input B Signal	INPUT B	
External Trigger Input	EXT mV/Trigger	
Generator Signal	Generator	
TV trigger on A	TV on A	
* External Trigger		
Input Connector	Dual Safety Banana Jack	External Trigger Input common (low) jack is electrically connected to the Input A and Input B commons (outer contacts of BNC's).
* External Trigger Input Impedance		
R parallel	1 MΩ ±1%	If used for mV DC/AC > 1MΩ.
C parallel	25 pF	Including Banana to BNC adapter
* Trigger Error		for frequencies < 1 MHz.
Voltage level	± 0.4 div	5 s/div...50 µs/div
	± 0.9 div	20 µs/div...10 ns/div 20 µs/div... 5 ns/div for models 99B and 105B
Time Delay	± 1 pixel ± 5 ns	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Maximum External Trigger Input (RMS)	300V	Up to 1 MHz; for frequencies > 1 MHz, see fig. 2.2
* Trigger Sensitivity		Values must be multiplied with 2.5 resp. 5 in 2 mV/div and 1 mV/div ranges.
* Input A or B		
Time base settings	≥ 50 µs/div	
Glitch detection off	≤ 0.4 div	
Glitch detection on	≤ 0.8 div	
Time base settings For models92B, 96B	≤ 20 µs/div	
≤ 10 MHz	≤ 1 div	
≤ 60 MHz	≤ 1.2 div	
≤ 110 MHz	≤ 2 div	
For models 9B, 105B		
≤ 10 MHz	≤ 1 div	
≤ 100 MHz	≤ 1.2 div	
≤ 150 MHz	≤ 2 div	
* External Trigger Input	selectable level 0.2 and 2V	TTL logic compatible using 10:1 resp 1:1 attenuation Probe.
* TV on A	≥ 1.5 div (pp) (minimum 30 mV) ≤ 21. div (pp)	
* Trigger Slope Selection	positive going negative going	
* Trigger Level Control Range		
Input A or B	± 4 div	When offset is positioned mid screen.
Trigger at 50%	0.5 x peak/peak value	Measured during 20 ms, max freq 10 MHz/1.5 div.
External trigger input	Fixed	
N-Cycle Mode		
5 s/div..1 µs/div	N=2...255	For time-base settings from 20 µs...1 µs/div acquisition and trigger on.
* Trigger Delay		
Range	-20...640 div	
Events 5 s/div..1ms/div	1...1023	Start via Ext; Count with Channel A.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* TV trigger (on A)		
TV trigger modes	lines	
	Frame	
	ODD/EVEN fields	
	line + linenumber	
	4 fields sequence	selectable by next frame "button" in menu
* Video modes	positive video	
	negative video	
* TV systems	NTSC	
	PAL	
	PAL-M	
	SECAM	
	NONINTERLACED	
* Scan rates	14...21 kHz	range LO
	19...33 kHz *	range MED
	31...65 kHz *	range HIGH
		* Non interlaced

2.7 SCOPE MODE TRACE DISPLAY

* Sources		A Maximum of 4 traces (3 live) can be selected [EXCEPT MODEL 92B].
	Input A	
	Input B	
	Input A + or - B	
	Input A versus B	(X-Y)
	Memory #1 up to 10	[MODEL 96B]
	Memory #1 up to 20	[MODEL 99B & 105B]
* Position range		
Horizontal	+ 4 div... 16.5 div	
Vertical	- 4 div...+ 4 div	From screen center, select per trace.
	- 3 div to + 3 div	With CURSORS on.

2.8 SCOPE MODE WAVEFORM MATH

* Functions		[EXCEPT 92B, 96B]
	Multiply	Uses entire Memory or Input waveform.
	Add	
	Subtract	For timebase settings from 20 µs to 10ns, for models 99B and 105B 20 µs/div...5 ns/div life (Input) waveforms can be used only when displayed on the LCD.
	Filter	
	Invert	
	Integrate	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.9 SCOPE MODE CURSORS

* Functions		[EXCEPT 92B]
	dV dt 1/dt Trig to left Trig to right V at left V at right Vrms VDC (mean) V peak/peak V max peak V min peak Frequency Rise Time Phase	maximum of 5 simultaneous measurement functions. Display as: - absolute values - absolute difference (δ) - relative difference (%)
* Horizontal		
Display Resolution	25 parts per div	
Digital Readout Resolution	3 digits digits	
Error Limit	± 0.1% ± 1 LSB	
Cursor Range	Visible part of signal	Cursors cannot pass each other.
* Vertical		
Display Resolution	25 parts per div	
Digital Readout Resolution	3 digits	
Error Limit		Referred to input at BNC or Probe tip, after Probe re-calibration.
For cursor measurements dV and Vpeak-peak	± (2% + 1 pixel)	
For other cursor measurements	± (2% + 0.2 div) or 1 mV	

2.10 CONTINUOUS SCOPE AUTOSET

General

The CONTINUOUS SCOPE AUTOSET function is divided into two parts

1. The initial AUTOSET action — Scanning all inputs to find out which input's have signals applied and to find initial settings.
2. The continuous AUTORANGE — Continuous tracking of the input signal by finding optimal settings for Trigger Level, Trigger Slope, Voltage Range and Timebase Range.

* Initital AUTOSET action

General

At initialization of AUTO SET a selection is made for:

Trigger source	EXT, A, B
Trigger slope	+ or -, whichever is most stable.
Trigger Level	15 or 85%, whichever is most stable.
Voltage range	see vertical aquisition
Timebase range	see horizontal aquisition

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

Defaults are chosen for:

Trigger source control	automatic
Trigger slope control	automatic
Trigger delay	-2 div
A B separation	+1 and -1 div
Input coupling	DC
Average	off
X-move	zero
Y-move	zero
A versus B	off
Cursors	unchanged
Generator	unchanged
Dot Join	unchanged

The defaults can be changed under USER OPTIONS.

* Continous AUTORANGE

General

The continuous AUTORANGE becomes active after the Initial AUTOSET action and finds optimal settings for Trigger Level, Trigger Slope, Voltage Range and Timebase Range. Switching to manual by manually changing Trigger Slope, Voltage Range or Timebase range leaves the other settings automatic. Manually changing Trigger Level results in complete manual setting.

*	Settling time	3 seconds typical	Depending on the complexity of the signal. Not specified when glitch on.
*	Horizontal Acquisition:		
	Timebase Range	20 ms/div .. 10 ns/div 20 ms/div .. 5 ns/div	model 92B, 96B model 99B, 105B
	Frequency Range	10 Hz...60 MHz 10 Hz...100 MHz	Models 92B, 96B Models 99B, 105B
	TB Deflection coefficient		
	Signal 40 Hz...5 MHz	min. 2, max 6 signal periods over 10 div	
	Signal 5 MHz...60 MHz	min. 2, max 20 signal periods over 10 div	Model 92B, 96B
	Signal 5 MHz...100 MHz	min. 2, max 20 signal periods over 10 div	Model 99B, 105B
	Trace Repeat mode	Recurrent	
	No signal state	200 µs/div	
*	Vertical Acquisition		
	Sensitivity Range	10 mV/div .. 100 V/div	Available trace area will be used as optimal as possible and is dependent on the vertical MOVE position

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Input signal conditions: (Input A and/or B)		
Signal peak-peak value range		Values must be multiplied with 2.5 resp. 5 in 2mV/div and 1mV/divranges
Time base settings ≥ 50 µs/div		
Glitch detection off	≤ 0.8 div	
Glitch detection on	≤ 1.2 div	
Time base settings ≤ 20 µs/div.		
For models 92B, 96B		
≤ 10 MHz	≤ 1.9 div	
≤ 60 MHz	≤ 2.1 div	
≤ 110 MHz	≤ 2.9 div	
For models 99B, 105B		
≤ 10 MHz	≤ 1.9 div	
≤ 100 MHz	≤ 2.1 div	
≤ 150 MHz	≤ 2.9 div	
DutyCycle range	5 .. 95%	
No signal state	Input at 50 mV/div	

2.11 MULTIMETER MODES

The Multimeter uses Input A for V DC & V AC measurements and the Safety Banana Jack Inputs for Resistance, Diode Test, Continuity, DC mV and AC mV measurements. An internal reference is used to optimize the accuracy of Input A and any probes used. The accuracy of all Multimeter measurements are within ± [(% of reading) + (number of least significant digits)] from 18°C to 28°C with relative humidity up to 90% for a period of one year after calibration. Add 0.1 x (specified accuracy) /°C for < 18°C or > 28°C Ambient.

- Displayed range include used probe, if calibrated.
- Values listed are without attenuating probe.
- Displays with no trigger are optimized for power line (mains) related measurements.

* DC Voltage Input A		
Ranges	100 mV, 300 mV, 1V, 3V, 10V, 30V, 100V, 300V	Manual or automatic ranging on peak Voltage. High Voltage 10:1 Probe extends measurement to 600V. Peak voltage is 2.5x Range, except 375V in 300V range.
Resolution	0.1 mV, 0.1 mV, 1 mV, 1 mV, 0.01V, 0.01V, 0.1V, 0.1V	Multiply x10 with 10:1 Probe.
Accuracy	± (0.5% + 5)	
Full Scale Reading	1000 / 3000 Counts	
Display update	< 250 ms	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Response Time		
Normal	< 3.5s	
SMOOTH	< 10s	
FAST	< 1s	
Zeroing	automatic	
Normal (Series) Mode Rejection Ratio	> 50 dB @ 50 Hz or 60 Hz	
* AC Voltage Input A Ranges	100 mV, 300 mV, 1V, 3V, 10V, 30V, 100V, 250V	Manual or automatic ranging on peak voltage. High Voltage x10 Probe extends measurement to 600V. Peak voltage is 2.5x Range and 375V in 250V range.
Resolution	0.1 mV, 0.1 mV, 1 mV, 1 mV, 0.01V, 0.01V, 0.1V, 0.1V	Multiply x10 with High Voltage Probe.
Accuracy		Valid from 5%..100% of range. [VALUES] for AC coupled input Vrms AC (no DC)
50 Hz...60 Hz	± (1% + 10)	
1[20] Hz...20 kHz	± (2% + 15)	Add 1% above 1 kHz using 10:1 Probe.
1[5] Hz...1 MHz	± (3% + 20)	For frequencies < 10 Hz with Probe, or < 100Hz direct, use function ac+dc.
1[5] Hz...5 MHz	± (10% + 25)	In AC+DC the DC component is included in the measurement result, and does not influence the accuracy.
Crest Factor	not applicable	Meter prevents crest factor errors by autoranging on input waveform peaks.
Full Scale Reading	1000 / 3000 Counts	
Display update	< 250 ms	
Response Time		
Normal	< 3.5s	Input freq ≥ 50 Hz.
SMOOTH	< 10s	
FAST	< 1s	
DC Common Mode Rejection Ratio	> 120 dB @ dc > 100 dB @ 50, 60, or 400 Hz.	
AC Common Mode Rejection Ratio	> 65 dB @ dc..60 Hz	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Resistance		
Open Circuit Voltage	< 4V	
Full Scale Voltage		
30Ω	< 25 mV	
...300Ω ... 3 MΩ	< 250 mV	< 250 mV
30 MΩ	< 2V	
Ranges	30Ω 300Ω, 3 kΩ, 30 kΩ, 300 kΩ, 3 MΩ, & 30 MΩ	Manual range only. Manual or automatic ranging.
Resolution	0.01Ω, 0.1Ω, 0.001 kΩ, 0.01 kΩ, 0.1 kΩ, 0.001 MΩ, & 0.01 MΩ	
Accuracy	± (2.5% + 25) ± (0.5% + 5)	30Ω range All other ranges
Full Scale Reading	3000 Counts	Up to 9999 counts in 30Ω range, Up to 3000 counts in 30 MΩ range, Up to 4500 counts in other ranges.
Measurement current	.5 mA...70 nA	Decreases as range increases.
Display update	< 250 ms	
Response Time		
Normal	< 3.5s	
SMOOTH	< 10s	
FAST	< 1s	
Protection	600V RMS	
Continuity		
Beeps if resistance is < :	5% of selected Range +/- 50 Counts	
* Diode Test		OL is indicated if measured Voltage is > 2.8V.
Maximum Voltage	4V	
Range	2.800V	
Resolution	0.001V	
Voltage Accuracy	± (0.5 % + 5)	Specification applies for voltage measurement
Digital Display	3000 Counts	If value > 2800 read out gives OL.
Measurement Current	.5 mA =/- 15%	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Display update	< 250 ms	
Response Time		
Normal	< 3.5s	
SMOOTH	< 10s	
FAST	< 1s	
Protection	600V RMS	
Polarity	+ on RED Banana Jack on BLACK Banana Jack	
* External mV mode	Displays multiple numeric readings and scope waveform picture of the signal at the Banana Jack inputs. Use for Accessory (including Temperature) input.	
DC Voltage		
Ranges	300 mV, 3V	
Resolution	0.1 mV, 1 mV	
Accuracy	± (0.5% + 5)	
Full Scale Reading	3000 Counts	
Display update	< 250 ms	
Response Time		
Normal	< 3.5s	
SMOOTH	< 10s	
FAST	< 1s	
Input	+ on RED Banana Jack - on BLACK Banana Jack	mV input. COM input.
Normal (series) Mode Rejection	>5 0dB at 50Hz or 60Hz	
Common Mode Rejection	>100 dB	at DC, 50, 60, or 400Hz
Probe Scaling		1 mV/°C, 1 mV/°F, 1 mV/A, 10 mV/A, 100 mV/A, 1V/A (1 mV/mA)
AC or AC+DC True RMS Voltage		
Ranges	300 mV, 3V	
Resolution	0.1 mV, 1 mV	
Accuracy	± (2% + 15)	>5% of range. DC, 50Hz or 60Hz
Full Scale Reading	3000 Counts	OL at >= 2500 counts in 3V AC range
Display update	< 250 ms	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Response Time		
Normal	< 3.5s	
SMOOTH	< 10s	
FAST	< 1s	
Input	+ on RED Banana Jack - on BLACK Banana Jack	mV input. COM input.
Common Mode Rejection	>60 dB, DC to 60Hz	
Probe Scaling		1 mV/A, 10 mV/A, 100 mV/A, 1V/A (1 mV/mA)
* Multimeter Math (Display) Functions		
Relative	ZERO Δ	Displayed Value = Reading - Reference Reading
% Change (% Relative)	ZERO %Δ	Displayed Value = [(Reading/Reference Reading) -1] x 100
% Scale		Displayed Value = [(Reading - Set 0% Reading)/(Set 100% Reading - Set 0% Reading)] x 100
Set 0% Reference	SET 0%	Present, Maximum, Minimum, Max - Min, Average, or User selected Reading.
Set 100% Reference	SET 100%	Present, Maximum, Minimum, Max - Min, Average, or User selected Reading.
Power with respect to 1 mW in selected load resistance	dBm	
Select load resistance	1200, 1000, 900, 800, 600, 500, 300, 250, 150, 135, 125, 110, 93, 75, 60 & 50	
Voltage Ratio in dB with respect to 1V	dBV	
Audio power	WATTS or dBW	
Select load resistance	50, 16, 8, 4, 2, & 1Ω	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Other Multimeter Operating Modes		
Touch Hold®	HOLD Causes the meter to capture the next measured reading (and beep) when a new stable measurement has been detected. When first enabled, the numeric display is frozen (held) until a stable measurement is detected. Stable measurements are defined as within ± 100 display counts for 1s; and above a floor of 200 display counts in volts (300 counts in ac, 0 counts in Ω and diode test). Overload is a valid stable condition except in Ω and diode test.	
MIN MAX TRENDPLOT™	Logs MIN, MAX, and AVERAGE readings to memory at full accuracy and displays all three as graphs. Uses automatic vertical scaling and horizontal time compression for hands-off from 15s/div. to 8 days/div. MIN MAX button. Time indication: - Relative to start of recording - Time of day.	
Realtime clock accuracy	60s/month	at 25 °C
* AUTO RANGE		Voltage and Time are coupled.
Voltage		RANGE key selects manual Voltage Range. The AUTOSET key restarts automatic voltage ranging.
Time		
range-up		
5 ms..50 µs	> 8 periods in display	TIME key selects manual timebase. The AUTOSET key restarts automatic timebase ranging.
20 µs...1 µs	> 4 periods in display	
range down		
5 ms..50 µs	< 1.5 periods in display	
20 µs...1 µs	< 0.75 periods in display	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Frequency		
Range	1Hz...2 kHz	Ext mV input. Manual for freq. < 20 Hz.
	1Hz..5 MHz	Input A. Manual for freq. < 20 Hz.
accuracy	± (.5 % + 2 counts)	@Signal level >10% of range
Timebase accuracy	± 0.01%	
Resolution	4 digits	
Measuring time	3.5s	gradually slower from 100 Hz and down
SMOOTH	< 10s	Running average over 32 measurements
FAST	< 1s	
Ranging	Automatic	
* Duty Cycle		Selectable Positive or Negative pulse inputs.
Range	2.0% to 98%	
Resolution	0.1%	
Accuracy	± (0.5% + 2 counts)	For logic or pulse signal inputs, @Signal level >10% of range
* RPM, Revolutions per Minute		Selectable: 1 pulse/rev. or 1 pulse/2rev.
Range	60RPM to 99.99kRPM	1 pulse/revolution. Manual for <1200 RPM.
	120RPM to 99.99kRPM	1 pulse/2 revolutions. Manual for <2400 RPM.
Resolution	1 RPM	10 RPM for RPM> 10,000
Accuracy	± (0.5% + 2 counts)	@Signal level >10% of range
* Pulse Width		Selectable Positive or Negative pulse inputs.
Range	250 µs to 50 ms	Input signal at 50% duty cycle.
Resolution	3 digits	
Accuracy	± (0.5% + 2 counts)	For logic or pulse signal inputs from 2% to 98% duty cycle. @Signal level >10% of range

2.12 GENERATOR

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Probe Adjust		A squarewave voltage is available via the generator output for adjusting probe compensation.
Voltage	5V	
Frequency	976Hz	
Source resistance	400Ω	
* DC Calibration		Including 10:1 attenuation Probe.
Voltage	3V	Inaccuracy is optimized internally.
Source resistance	400Ω	
* Sinewave		[EXCEPT 92B & 96B]
Amplitude	1V	
Frequency	976Hz	
Maximum Individual Harmonic	3%	
Source Resistance	400Ω	
* Squarewave		[EXCEPT 92B & 96B]
Amplitude	5V	
Frequency	1.95 kHz 976Hz 488Hz	Selectable
Source Resistance	400Ω	
* Current Ramp		[EXCEPT 92B & 96B]
Amplitude	0 to +3 mA	in 128 steps, time for each step can vary.
Maximum Compliance Voltage	2V	
* Voltage Ramp		[EXCEPT 92B & 96B]
Amplitude	-2V to +2V	in 128 steps, time between steps can vary.
Maximum Current	± 1 mA	

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.13 SET-UP, WAVEFORM, & SCREEN MEMORIES

* SET-UP MEMORY		[EXCEPT 92B]
Memory size	20 maximum 40 maximum	[96B] Front Panel Set-ups [99B & 105B] Front Panel Set-ups
Functions	Save	Actual front panel settings are stored in memory, replacing contents of memory location indicated on the LCD.
	Delete	Contents of memory location indicated on the LCD are deleted.
	Recall	Actual front panel settings are replaced by contents of memory location indicated on the LCD.
* WAVEFORM MEMORY		[EXCEPT 92B]
Memory size	10 maximum 20 maximum	Waveforms [96B] Waveforms [99B & 105B]
Functions	Save	Waveform indicated on the LCD is stored in memory, replacing contents of memory location indicated on the LCD.
	Delete	Contents of memory location indicated on the LCD are deleted.
Recall	Recall	Waveform in memory location indicated on the LCD is placed on the display.
* SCREEN MEMORY		[EXCEPT 92B]
Memory size 10 maximum	5 maximum 10 maximum	Screens [96B] Screens [99B & 105B]
Functions	Save	The entire display screen and actual front panel settings are stored in memory, replacing contents of memory location indicated on the LCD.
Delete	Delete	Contents of memory location indicated on the LCD are deleted.
Recall	Recall	The entire display screen is replaced by the contents of the memory location indicated on the LCD.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

2.14 POWER ADAPTOR / BATTERY CHARGER

* Input Connector	5 mm Power Jack	Per DIN 45323
* Source Voltage dc		
Nominal	15V dc	
Lmits of Operation	8V...20V dc	
* Charging Current		
Instrument ON	70 mA	
Instrument OFF	220 mA	
* Allowable Temperature During Charging	0°C...45°C	
* Power Consumption		
Instrument ON	7W	
Instrument OFF	3W	

2.15 POWER SUPPLY

* Battery Voltage Range	4V...6V

The batteries are not charged at delivery. A Warning is given if the battery voltage becomes lower than 4.6V. The instrument is switched off if the battery voltage becomes lower than 4V. If the instrument is Battery Powered, it will switch off automatically after 10 minutes of no operator actions, except in MIN MAX or ROLL modes.

* Recommended Batteries		
All Models		
NiCd Battery Pack	PM 9086/011	Only this Battery Pack is internally re chargeable.
Recharging time	21 hours	
Life time		After 500 cycles the capacity will be > 1100 mAh. The nominal capacity is 2800 mAh.
Operating time	> 4 hours	After Charging for > 25 hours at low backlight intens level.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
Stand Alone Batteries (4x)		
Model	KR27/50 K70 C-CELL	Per IEC Per ANSI
Operating time	> 4 hours	
Temperature Rise of Batteries	20°C	After instrument has reached a stable operating temperature.
Temperature Range of Batteries.		
Working	20°...65°C	
Storage	30°...65°C	It is recommended to remove the batteries from the instrument when it is stored longer than 24 hours below 30 °C or above 65 °C.

CAUTION! UNDER NO CIRCUMSTANCES SHOULD BATTERIES BE LEFT IN THE INSTRUMENT @ TEMPERATURES BEYOND THE RATED SPECIFICATIONS OF THE BATTERIES BEING USED!

2.16 MECHANICAL

*	Height	262 mm	With holster 281 mm
*	Width	129 mm	With holster 140 mm
*	Depth	60 mm	With holster 62 mm
*	Weight	1.5 kg	With holster 1.8 kg

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Temperature		Batteries removed from instrument unless batteries meet the required temperature specifications. Maximum Operating Temperature derated 3 °C for each km. (each 3000 feet) above sea level.
Operating	0°C...50°C	
Non Operating (Storage)	-20°C...70°C	
* Maximum Humidity		
Non Operating (Storage)	95% Relative Humidity	
Operating		
20°C...30°C	90%	
30°C...50°C	70%	
* Maximum Altitude		Batteries removed from instrument unless batteries meet maximum altitude specifications.
Operating	3 km (10 000 feet)	
Non Operating (Storage)	12 km (40 000 feet)	
* Vibration (Operating)		
Frequency 5...15 Hz	Sweep Time 7 min.	
Excursion (pk to pk)	1.5 mm	
Max Acceleration	7 m/s^2 (0.7 x g)	@ 15Hz
Frequency 15...25 Hz	Sweep Time 3 min.	
Excursion (pk to pk)	1.0 mm	
Max Acceleration	13 m/s^2 (1.3 x g)	@ 25Hz
Freq. 25...55 Hz	Sweep Time 5 min.	
Excursion (pk to pk)	0.5 mm	
Max Acceleration	30 m/s^2 (3.0 x g)	@ 55Hz
Resonance Dwell	10 min.	@ each resonance frequency (or @ 33 Hz if no resonance is found).

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Shock (Operating)		
Number of shocks	18 Total 6 Each Axis	(3 in each direction)
Shock Wave Form	Half Sine	
Duration	6..9 ms	
Peak Acceleration	400 m/s^2 (40 x g)	
* Bench Handling		
Meets requirements of:	MIL STD 810, Method 516, Procedure VI	
* Salt Atmosphere		
Structural parts meet	MIL STD 810, Method 509, Procedure I with 5 % salt solution	
* EMI (Electro Magnetic Interference)		
Meets requirements of:	MIL STD 461 Class B	Applicable requirements of Part 7: CE03, CE07, CS01, CS02, CS06, RE02, RS03. (RS02: max 2 div distortion in 20 mV/div).
	VDE 0871 Grenzwertklasse B	
* Packing meets requirements of:	UND 1400	
* Transportation meets requirements of:	AN D628	
Packaged Transportation Drop Meets requirements of:	Nat. Safe Transp. Assoc. Procedure 1A B 2	
Packaged Transportation Vibration Meets requirements of:	Nat. Safe Transp. Assoc. Procedure 1A B 1	
ESD (ElectroStatic Discharge) Meets requirements of:	IEC 801-2	Test severity level 15 kV.
Water and Dust protection	IP 51	According to IEC 529

2.18 OPTICAL-TO-RS232 INTERFACE

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION
* Type of interface	RS232	Uses PM9080/001 Optically Isolated RS232 Adapter/Cable.
	9 pole D-plug male	
* Spacing		
"0"	Light	
"1"	No light	
* Functions for printers:		
Baud Rate	1200, 9600	Input and Output are the same
Number of STOP-bits	1	
Parity	No	
Character length	8	
Transmission mode	Asynchronous, full duplex	full duplex
Handshake	XON/XOF	Software handshake only
* Interfacing function Repertory for interface:		
Baud Rate	75...19k2	Input and Output are the same. Selectable by Controller.
Number of STOP-bits	1 or 2	
Parity	No, odd or even	
Character length	7 or 8	
Transmission mode	Asynchrone, full duplex	
Handshake	XON/XOF or no Handshake	Software handshake only; default: no Handshake
* Print facilities		[EXCEPT 92B]
Protocol	FX/LQ graphic, Thinkjet Deskjet, Laserjet	
print out	Screen log of readings: single every 2, 5, 10 or 60s	
	selectable waveform	
* Front Panel Control		
Modes	Local	Front panel exclusively under manual control.
	Remote-locked	Front panel exclusively under RS-232-C control.
	Remote-unlocked	Return To Local by User ReQuest.

CHARACTERISTICS	SPECIFICATIONS	ADDITIONAL INFORMATION

* CPL Commands implemented:

ALL MODELS:

CPL Version Query	CV
Default Setup	DS
IDentification query	ID
Program Communication parameter	PC
Print Screen (Query Print)	QP
Read Date	RD
Read Time	RT
Reset Instrument (Master Reset)	RI
Status Query	ST
Write Date	WD
Write Time	WT

MODEL 96B,99B,105B ONLY:

View Screen	VS

MODEL 99B & 105B ONLY:

Auto Setup	AS
Arm Trigger	AT
Go to Remote	GR
Go to Local	GL
Instrument Status	IS
Local Lockout	LL
Program Setup	PS
Program Waveform	PW
Query for Measurement data	QM
Query Setup	QS
Query Waveform	QW
Recall Setup	RS
Save Setup	SS
Trigger Acquisition	TA

2.19 SAFETY

* Meets requirements of:	IEC 1010-1	For 600 V, Installation Category III, Pollution Degree 2.
	ANSI/ISA S82 UL 1244 CSA C22.2 No.1010.1	4 kV, 6 kV with PM8918 probe.
* Approvals	UL 1244 CSA C22.2 No.1010.1	

2.20 ACCESSORIES

* Accessories furnished with instrument:
  2 x 10 MΩ 10:1 Passive
  Safety Probes. PM 8918

  Scope Probe Accessory set: PM9094/001
  - 2 x HF adapter black
  - 2 x High Voltage testpin
  - 2 x mini test hook
  - 2 x Trim screw driver
  - 4 mm adapter

  Alligator Clip red (for 10:1 probe)
  Alligator Clip grey (for 10:1 probe)

  Set Testleads and Testpins:
  - 2 x testleads 1.5 m
  - 2 x testpins
  - 2 x banana adapter
  - 1 x Indust. Alligator Clip black

  Holster PM 9083/001
  For model 105B PM 9083/011

  Accessory case C 75

  Operating Manual

  Power Adaptor / Battery Charger:

	PM 8907/801	Depending on model one of: Universal Europe.
	PM 8907/803	North American.
	PM 8907/804	United Kingdom.
	PM 8907/806	Japan
	PM 8907/808	Universal 115V/ 230V.

  For model 105B only Hardcase
  FlukeView for Windows Software

2.21 SERVICE AND MAINTENANCE

* Mean Time Between Failures 40 000 hours — Predicted value, calculated through Parts Counting Method, according to MIL HDBK 217E.
* Mean Time to Repair 1.5 hours
* Calibration Interval 1 Year
* Mean Time To Calibrate 0.5 hours
* AQL-level (for outgoing inspection) 1

3 CIRCUIT DESCRIPTIONS

3.1 INTRODUCTION TO CIRCUIT DESCRIPTION

3.1.1 General

This chapter presents a layered description of the ScopeMeter test tool circuitry. First the overall theory of operation is described, referring to the overall block diagram (section 3.2).
The next section gives some information concerning the data acquisition.
Then the circuits on the digital (A1), the analog (A2) printed circuit boards (PCB), and the TV TRIGGER (A3) printed circuit board (PCB) are described. After a short introduction, a detailed circuit description is given for each circuit part.

The various circuit descriptions refer to the circuit diagrams in chapter 9.

NOTE: The large digital (A1) and analog (A2) printed circuit board diagrams are provided as separate drawings. Whenever a signal line continues on another drawing, it is indicated by the following comment:

"FROM A1" ----> coming from the digital (A1) circuit (figure 9.8)

"TO A2a" ----> the signal continues on the first circuit diagram of the analog A2 PCB (figure 9.5)

3.1.2 Location of electrical parts

The item numbers of C..., R..., V..., N..., D... and K... have been divided into groups. These groups relate to the functional parts on the PCBs:

Table 3.1 Location of electrical parts

Item number	Functional part	PCB	diagram
1200-1299	µP, Digital ASIC, M-ASIC, ROM, RAM and related circuitry	A1	A1a/b
1300-1399	battery sense, RAM power, receiver, transmitter	A1	A1a
1400-1499	LCD and related circuitry, backlight	A1	A1b
1500-1599	ON/OFF circuit, RESET circuit	A1	A1a
2100-2199	attenuator channel B	A2	A2a
2200-2299	attenuator channel A	A2	A2a
2300-2399	Analog ASIC and ADC	A2	A2a/b
2500-2599	battery charger and power supply	A2	A2c
2700-2799	EXTernal input-/output circuitry	A2	A2b
2800-2899	generator	A2	A2b
2900-2999	analog control circuitry	A2	A2a
3000-3050	tv trigger PCB	A3	A3

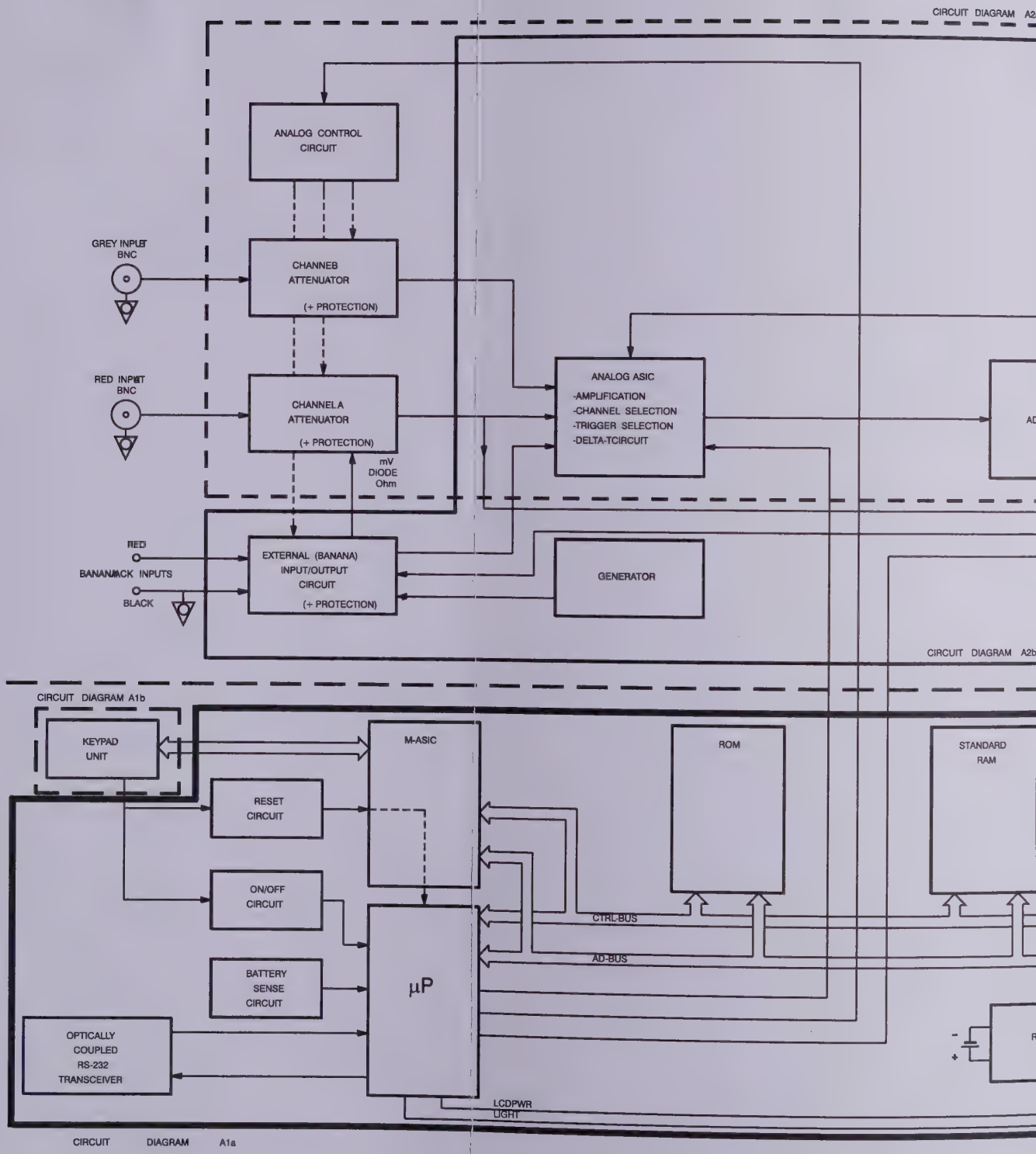
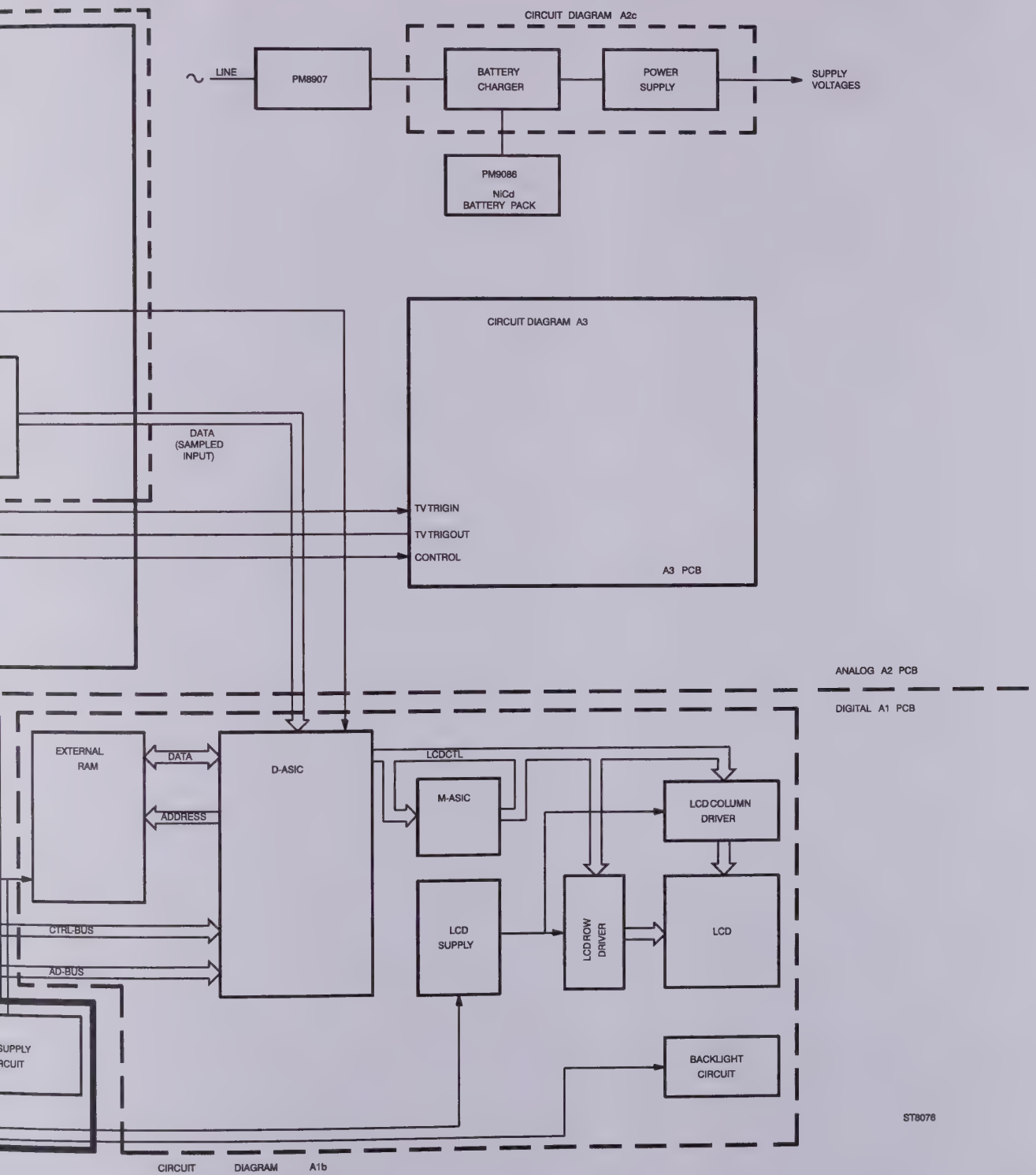


Figure 3.1 Overall Functional Block Diagram


CIRCUIT DIAGRAM A2c
LINE
PM8907
BATTERY CHARGER
POWER SUPPLY
SUPPLY VOLTAGES
PM9086
NiCd BATTERY PACK
CIRCUIT DIAGRAM A3
DATA (SAMPLED INPUT)
TV TRIGIN
TV TRIGOUT
CONTROL
A3 PCB
ANALOG A2 PCB
DIGITAL A1 PCB
EXTERNAL RAM
DATA
ADDRESS
D-ASIC
LCDCTL
M-ASIC
LCD COLUMN DRIVER
LCD SUPPLY
LCD ROW DRIVER
LCD
CTRL-BUS
AD-BUS
BACKLIGHT CIRCUIT
ST8076
CIRCUIT DIAGRAM A1b

3.2 FUNCTIONAL BLOCK DESCRIPTION

3.2.1 Introduction

This section contains an overall block diagram of the ScopeMeter test tool. Refer to figure 3.1.

The block diagram can be divided in three parts. The upper left part of the diagram shows the components that are situated on the Printed Circuit Board (in the following text: PCB), that is connected to the ScopeMeter's test tool bottom cover. Because this PCB contains mainly analog circuits, it is called the **analog A2 PCB**.

The upper right part is the **TV TRIGGER A3 PCB**. It is connected via three connectors to the **ANALOG A2 PCB**.

The lower part of the diagram contains the digital circuitry. This circuitry is located on the **digital A1 PCB**, the PCB connected to the top cover.

The general layout of the block diagram is the same as the layout of the circuit diagrams in chapter 9. The circuits that can be found on the same circuit diagram (chapter 9) are placed in a dashed box in the *block diagram.*

Analog A2 PCB
The signals at the red and grey BNC are attenuated by the **CHANNEL A ATTENUATOR** and the **CHANNEL B ATTENUATOR**. These attenuators are set by the Microprocessor (on the digital A1 PCB) via the **ANALOG CONTROL CIRCUIT**. Also input protection circuits are provided here.

The output signals of the attenuator blocks are fed to the **ANALOG ASIC** (ASIC = Application Specific Integrated Circuit). This component is controlled by the microprocessor on the digital A1 PCB. The Analog ASIC incorporates signal amplification and channel selection. It also prepares the signal for sampling by the **Analog to Digital Converter (ADC)**.

The output signal of the **CHANNEL A ATTENUATOR** is also used as input signal for the TV TRIGGER A3 PCB.
The output of the TV TRIGGER A3 PCB is fed to the **EXTERNAL INPUT/OUTPUT CIRCUIT**. Here the µP selects between the external or the TV trigger signal

The red and black banana jack inputs are connected to the **EXTERNAL (BANANA) INPUT/OUTPUT CIRCUIT**. When the ScopeMeter test tool is set to EXT mV, DIODE TEST or OHM mode, the External (banana) input/output circuit outputs its signal into the Channel A Attenuator section. In SCOPE mode, the circuit can act as a trigger input. The trigger signal is fed to the Analog ASIC. In the Analog ASIC "channel A", "channel B" or "External trigger" can be selected as trigger source. The trigger signal is used to generate the DELTA- T voltage (time relation between trigger moment and sampling moment).

The built-in **GENERATOR** uses the External (banana) input/output circuitry as output. It is possible to generate a DC voltage and a square wave voltage. Model 99B and 105B also can generate sine wave voltages, a ramp voltage, and a ramp current.

The power supply circuitry is also located on the analog A2 PCB. The separate Power adapter/battery charger **PM8907/...** converts the line voltage into 15V DC. This voltage is used by the **BATTERY CHARGER** to charge a **NiCad BATTERY PACK (PM9086/011)**, if present.

The **POWER SUPPLY** section transforms the input voltage (line operated) or the battery voltage (battery operated) into the supply voltages for the various circuits on A1, A2, and A3.

Digital A1 PCB

The ScopeMeter test tool is controlled by the **MICROPROCESSOR**, located on the digital A1 PCB. This microprocessor performs several control tasks, for example:

- Scanning the **KEYPAD** for user commands. The keypad is connected to the microprocessor via the **M-ASIC**.
- Communication with the outside world via the **OPTICALLY COUPLED RS-232-C TRANSCEIVER**. This section contains an Infrared LED (transmitter) and a phototransistor (receiver).
- Monitoring the battery voltage (**BATTERY SENSE CIRCUIT**).
- Controlling the Analog ASIC on the analog A2 PCB.
- Switching the power on or off (**POWER ON/OFF CIRCUIT**).
- Performing a proper RESET at power on (**RESET CIRCUIT**).
- Controlling the analog A2 circuits (via the **ANALOG CONTROL CIRCUIT**).
- Controlling the A3 circuits.
- Signal processing of acquired data. The microprocessor reads, calibrates and stores the acquired data.

The **DIGITAL ASIC** is the core of the digital circuitry. It provides:

- Timebase functions. For example: the ADC sampling signal is generated by the Digital ASIC.
- Trigger functions (in real-time sampling mode).
- Acquisition Control Logic (ACL). This function controls the acquisition according to trigger and acquisition modes. The Digital ASIC contains acquisition RAM for quick data storage.
- Min/Max mode.
- Decoding of the internal ASIC addresses and synchronization of Digital ASIC and microprocessor access to the acquisition RAM.
- Display control. The Digital ASIC generates the picture to be displayed on the LCD.

The picture, generated by the Digital ASIC is displayed on the **Liquid Crystal Display (LCD)**. The LCD is controlled by the **LCD ROW DRIVERS** and the **LCD COLUMN DRIVERS**. The **LCD SUPPLY** section provides for the voltages needed. ScopeMeter test tool has a **BACKLIGHT CIRCUIT**, which can illuminate the LCD.

In the **MEMORY ASIC** (M_ASIC) a number of circuits are integrated:

- ADDRESS LATCH circuit
- MEMORY MANAGER, to control ROM and RAM
- KEYBOARD SCANNER
- BOOT CIRCUIT, to perform a correct startup
- LCD control circuits ODD/EVEN SELECTION and AB-MIX (RANDOMIZE)

3.2.2 Data acquisition

- Data acquisition path

The analog input signals are first attenuated and/or amplified and then converted into digital values by the ADC. The samples of the input signals are stored in the Acquisition RAM of the Digital ASIC. If 512 samples are stored in memory, the second trigger pulse will signal the microprocessor that the acquisition is ready. (We assume that the test tool is using random repetitive sampling, see next section.) Then the acquired data is ready for processing. The microprocessor reads the data from the Acquisition RAM and processes the data according to the actual calibration values. These calibration values (constants) are copied from Flash ROM to RAM during startup. The calibration values have been stored in Flash ROM during the calibration process. After processing, the data is stored in the External RAMs. These RAMs also contain the more static picture elements, for example the grid-, cursor- and text data.

- A multitasking kernel for hardware and software scheduling

Processing the acquired data is only one of the tasks of the microprocessor. The test tool uses a multitasking kernel for hardware and software scheduling, based on internal and external interrupts. The microprocessor contains internal timers, which can be programmed by the software. One of these timers is used to generate interrupts, e.g. to scan the keypad for depressed or released keys.

Except processing (calibrating) the acquired data, the microprocessor also does mathematical computations and controls the hardware. The multitasking kernel takes care that every 20 ms of processing time, a task is interrupted. This task will then be held and rescheduled, unless it requires execution without interruption. In this way a variety of user-requested tasks can be handled quasi-simultaneously, without the user being aware of the heavy loads on the microprocessor. The display of the data on the LCD is done by the Digital ASIC, also taking part in the multitasking scheme.

- Sampling and Triggering

The test tool uses two types of sampling, commonly used in many Digital Storage Oscilloscopes: **REAL-TIME SAMPLING** and **RANDOM REPETITIVE SAMPLING**.

In the real-time sampling mode (timebase settings: 60s/div...1 µs/div) the test tool takes a series of samples from a single period of the input signal. These samples are later used to reconstruct the signal. During the real-time sampling mode, the Digital ASIC calculates the trigger pulses out of the acquired data (for timebase settings between 60s/div...50 µs/div). For timebase settings between 20 µs/div and 5 ns/div, and for external triggering, the triggering is done by the Analog ASIC, using analog comparators.

In random repetitive sampling mode (time base 500 ns/div ... 5 ns/div), the test tool takes a sample from successive cycles in a repetitive signal. These samples are stored in memory and combined to reconstruct the original signal.

In this sampling mode, samples are taken from the input signal at intervals determined by the internal clock. Since there is no time-correlation between the system's clock and the incoming signal, all samples are taken at random points of the signal. The time between the trigger moment and the sampling moment must be tracked to enable reconstruction of the signal from the samples. This time, DELTA T, is generated by the Analog ASIC. See section 3.4.5 and figure 3.12.
During random repetitive sampling mode, the test tool always uses analog triggering (Analog ASIC).

3.3 DIGITAL CIRCUITS (A1)

3.3.1 Introduction

The following paragraphs describe the circuits on the digital A1 PCB in detail. Refer to circuit diagrams figure 9.2a and 9.2b in chapter 9.

3.3.2 Overview digital circuits

The digital circuitry of the ScopeMeter test tool can be separated into three main parts:

- Microprocessor circuitry
- Digital ASIC (in the following text: D-ASIC) circuitry
- LCD circuitry

A block diagram, which clearly shows the connections between these main parts, is shown in figure 3.1.

3.3.3 MICROPROCESSOR circuitry (µP)

- Introduction

The ScopeMeter test tool is controlled by a single chip microcomputer with on-board ROM (called Mask ROM in the following text). This microprocessor controls the total system operation and communication between the test tool and the outside world (key pad, RS-232-C interface). It also controls the communication between the internal system components.

- Detailed circuit description

See figure 3.1 and circuit diagram A1 (figure 9.2a).

Microprocessor

The ScopeMeter test tool uses an Intel 83C196 microprocessor (D1201), with on-board Mask-programmed ROM (Mask ROM). This microprocessor has a 16-bit multiplexed Address/Data-bus (called AD-bus in the following text). The address bits are latched in the M-ASIC D1210. The M-ASIC also buffers the microprocessor AD- bus.

The microprocessor's Mask ROM contains the startup software and a diagnostic kernel test (see chapter 7). It also contains the software to drive the serial RS-232-C interface. This enables the microprocessor to load software into the STANDARD ROM (Flash ROM).

STANDARD ROM D1242, 4M Flash EPROM, containts the system software.

The STANDARD RAM contains, amongst others, the actual ScopeMeter test tool settings, saved waveforms, saved setups, saved screens, and results of calculations on acquisition data. One of the following RAMs can be mounted: D1232 (M5M5256BRV, 32K*8), or D1230 (HM628128AR, 128K*8). The RAMs are powered by the RAM POWER circuit, which is battery backed up.

STANDARD ROM and STANDARD RAM are connected to the microprocessor via the AD- bus. The addresses are latched in the M-ASIC first.

The microprocessor contains five 8-bit I/O ports. Port 3 and 4 share their bits with the Address/Data bus. The other I/O ports 0, 1 and 2 are used for various purposes. For example: operating the RS-232-C interface, battery sense, switching the power on/off, switching the backlight on/off, etc.

Keypad circuitry.
The keypad switches are arranged in a matrix. The microprocessor controls the rows and reads the columns of the keypad matrix via the M-ASIC. If no key has been pressed, all ROW lines are set low. As the column lines are connected to the +5V supply via pull-up resistors located in the M-ASIC, the microprocessor reads high levels on all column lines.

Suppose that key F1 is pressed. Then column line COL0 goes low and the microprocessor detects that a switch in column 0 is pressed. Now the row lines are sequentially made high, and the microprocessor watches column line COL0 to see for which row line the COL0 line goes high. As key F1 is pressed, a high level on row line 0 will cause column line COL0 to go high.

Optically isolated RS-232-C interface
The serial communications circuitry, which is built into the microprocessor, is used to operate the infrared (IR) RECEIVER and TRANSMITTER of the ScopeMeter test tool. For this purpose a stripped version of the RS-232-C protocol is used.

Only the TXD (transmit data) and RXD (receive data) lines from the RS-232-C standard are used. The IR transmitter LED H1201 is driven directly from the TXD-not pin of the microprocessor. If a "0" is transmitted, the LED lights.

The IR receiver uses operational amplifier N1301 to power the collector of phototransistor H1202. If any IR light is received, the phototransistor will drive V1207 in saturation. This results in a "low" RXD line, interpreted by the microprocessor as a "1".

Battery sense circuitry
The battery voltage -VBAT generated on the analog unit is amplified by -2/3 at operational amplifier N1301. The resulting signal BAT_LEVEL is connected to an A/D converter input of the microprocessor. In this way the microprocessor can monitor the battery voltage level. If the battery voltage level drops below 4.3V, the microprocessor generates the BATTERY LOW indication on the LCD. If the level drops below 3.9V, the ScopeMeter test tool switches off.

Analog ASIC bus
The Analog ASIC (A-ASIC D2301, see circuit diagram A2a/A2b, figure 9.5/9.6) or A-ASIC, as used in the following text, is controlled by the microprocessor. The microprocessor uses the signals CDAT, CCLK and DTAEa,b,c to set the A-ASIC and the attenuator sections on the analog A2 PCB. These signals together form the CONTROL bus on the analog A2 PCB.

ON/OFF circuit.
To switch the test tool on/off, transistor V2542 in the power supply part on the Analog Board A2 must be made conductive/non-conductive (refer to section 3.4.9). If transistor V1503 is non-conductive, the POWER ON line (X1201:1) is open (high impedance). As a result V2542 is non-conductive as its gate-source voltage is zero (N-channel enhancement FET).

Switching ON:
The ON/OFF circuit operates almost like a thyristor. When the ON/OFF key is pressed, a current flows from +VRAM via R1502, R1503 V1502a, V1504, V1505, V1506 and R1507 to -VBAT. Transistor V1501 will become conductive. The POWER ON line goes high (+VRAM), and FET V2542 conducts as its Vgs becomes 8V (+VRAM -VBATT). Now the supply has been turned on. The microprocessor will set the ON/OFF line low. The Vbe of V1503 increases by the current drawn via V1501, R1504, R1505, V1502b and R1506. V1503 becomes conductive, and keeps V1501 conductive (thyristor function "on").

Note: If the µP does not set the ON-OFF line low, the supply will not stay on when the ON/OFF key is released. To keep the supply on, independent of the µP, solder pad J1501 must be closed. This can be helpful at troubleshooting.

Switching OFF:
When the ON/OFF key is pressed during power-on, the ON-RESET line goes low. The microprocessor receives a reset signal UPRESETN via V1513, D1215, and the M-ASIC (in: RESETN, out: uPRESETN). It will make the ON/OFF line high, and as a result V1503 and V1501 become non-conductive. The POWER ON line is now open (high impedance) and FET V2542 becomes non-conductive.

RESET circuit
The RESET circuit consists of V1510, V1512, V1513, D1215 and related components. When the ScopeMeter test tool power is switched on, the +5V supply voltage starts to rise. This causes the zener diode V1511 to conduct. After some time transistor V1510 also starts to conduct.
R1514 and C1510 form a time delay.

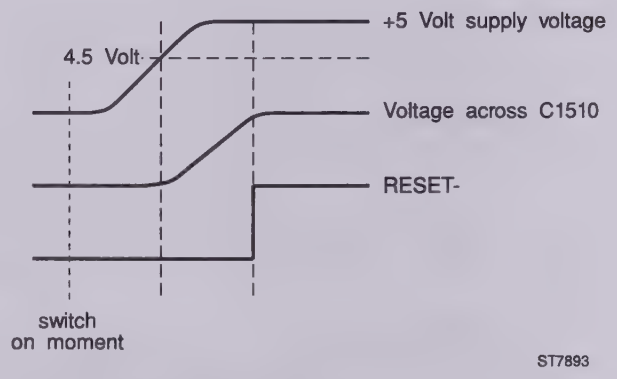


Figure 3.2 RESET signal timing

The RESET signal now is buffered by D1215 and connected with the RESET inputs of the M-ASIC (BOOT CIRCUIT) and the D-ASIC circuitry. The RESETN signal controls the EAN output of the M -ASIC.
After a reset, the voltage on the EA (External ACCESS) input of the microprocessor (pin 14) is "high" (EAN signal). The microprocessor starts up using the internal Mask ROM software. First the Flash ROMs are checked to see if they contain valid software. If this is true, the EAN line is set "low". Now the microprocessor invokes a software reset. Because of the "low" voltage on the EA input of the microprocessor, the microprocessor will "start up" again, using the external Flash ROM software. At the software reset, the microprocessor also enables the LCD by means of the signal LCDPWR.

3.3.4 DIGITAL ASIC (D-ASIC) circuitry

- Introduction

The Digital Application Specific Integrated Circuit (or D-ASIC) D1203 forms the core of the digital circuitry of the ScopeMeter test tool, all located on the digital A1 PCB.
Many functions are incorporated in this complex CMOS integrated circuit (see figure 3.4 on the next page):

- Timebase
- Trigger
- Acquisition Control Logic
- Acquisition RAM
- Min/max
- Display control
- Decoding and synchronization
- Digital-to-analog converters (DACs)

- Detailed circuit description:

See figure 3.3 and circuit diagram A1 (figure 9.2b).

The following gives a short description of the separate parts of the D-ASIC, which perform the functions mentioned above:

Timebase
The D-ASIC contains a crystal oscillator, which uses the 25 MHz crystal G1201. An internal programmable divider generates timebase signal TRACK with a frequency from 0.8333 Hz up to 25 MHz (see section 3.4.5). This TRACK signal is used to sample the input signals.

Trigger
The trigger module in the D-ASIC takes care of all trigger related functions:

- pre triggering
- post triggering
- event counting: the time interval corresponding to the trigger delay is increased by a programmed number of "events" (trigger level crossings of the external trigger signal), which must occur before triggering.
- n-cycle mode: trigger level crossings of the input signal are counted, and triggering occurs every n^{th} crossing ($2 < n < 255$). The n-cycle mode can be used as a digital trigger hold-off.

In the real-time sampling mode (time base 60s/div ... 1 µs/div), the D-ASIC determines the trigger moment with digital comparators. In the quasi-random sampling mode, the A-ASIC determines the trigger moment with analog comparators.

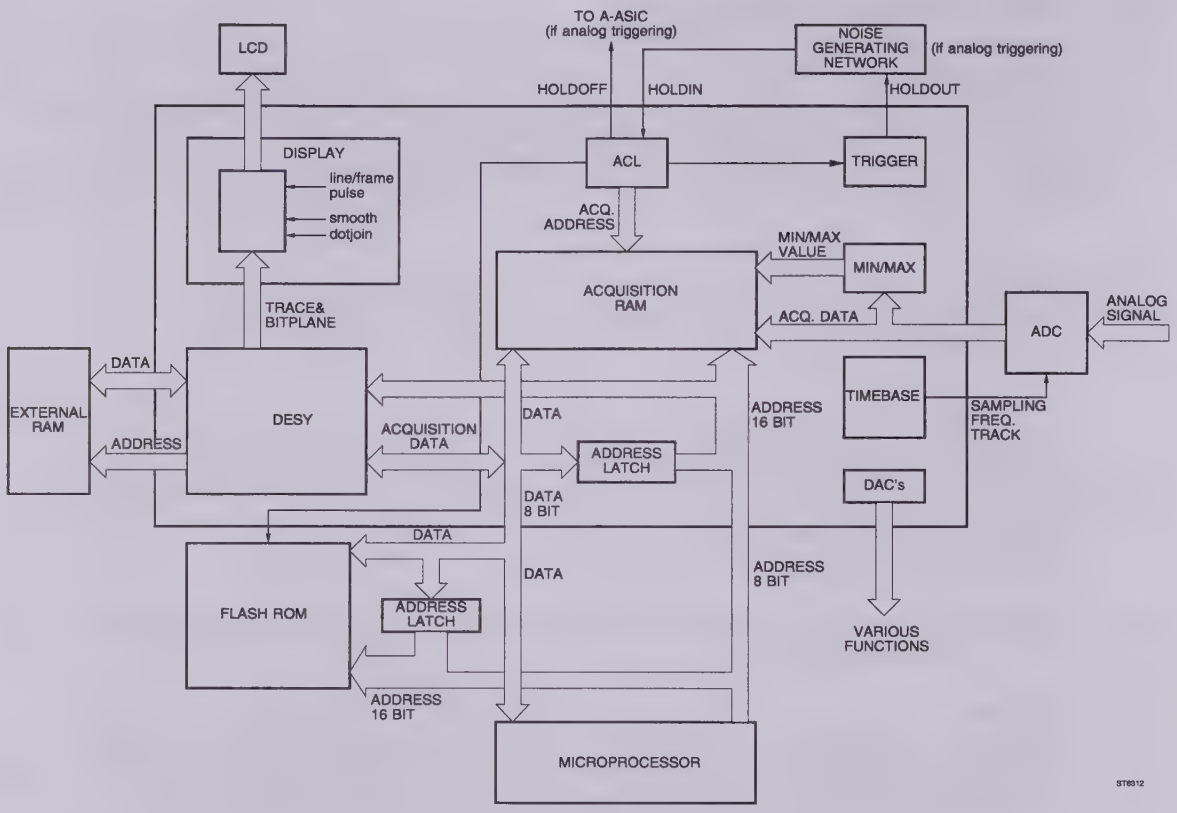


Figure 3.3 Schematic Diagram D-ASIC D1203

Acquisition Control Logic (ACL)

The ACL controls the analog input circuitry and the ADC (N2302, see circuit diagram A2a/A2b, figure 9.5/9.6). The ACL also writes the digital representations of the input signals to the Acquisition RAM in the D-ASIC, according to the selected trigger and acquisition modes. Before the acquired trace data is displayed, it is first processed by the microprocessor. The microprocessor corrects for offset- and amplification errors, using the calibration values that are stored in Flash ROM.

In fast timebase positions the ACL acquires 1024 values. Then the acquisition is stopped and the microprocessor can read the data out of the Acquisition RAM. In slow timebase positions the ACL uses the Acquisition RAM as a FIFO (First In First Out) memory. The microprocessor can start reading the acquired data immediately after triggering. Now there is synchronization between the ACL and the microprocessor.

If the system uses analog triggering (time base 20 µs/div ... 5 ns/div), the trigger hold-off signal (HLDOFFN) to the A-ASIC is generated. The D-ASIC generates the HLDOUTN signal. This signal is fed to the HLDIN input of the D-ASIC, via R1259 and C1257. These components generate jitter on the HOLDOFF signal, which is needed as a random factor in the Delta- T circuit.

Glitch detect

The Min/max module finds the minimum and maximum value of the input signals between two time base pulses, and writes them into the Acquisition RAM. To detect narrow glitches, the TRACK signal (ADC sample frequency) is always 25 MHz when GLITCH DETECT is selected.

Display control
This module reads screen data from the External RAMs (D1208, D1209 or D1218) and sends it to the LCD. It also sends line pulses LINECL (17 kHz) and frame pulses FRAME (70 Hz). This screen data, consisting of for example cursor and grid information, is stored in External RAMs as bitplane information. The trace data is stored as a value for every vertical line on the LCD. This data is converted to bitplane data and added to the cursor and grid information. The display control module also makes it possible to change the dotsize of the signal displayed and to use dot joining.

Decoding and synchronization (DESY)
The DESY section is the decoder for the D-ASIC's internal addresses. This module also synchronises the microprocessor with the D-ASIC's Display control module, as both access the same Acquisition RAM.

Digital to analog converters (DACs)
The DACs module contains 10 one-bit pulse width modulated monotonous DACs, whose resolution ranges from five to ten bits. The DACs are used to control level shifting, analog trigger level, LCD contrast and the generator function (see section 3.4.7).

External RAMs

One of the following RAMs can be mounted: D1208 (HM62256AR, 32K*8), D1218 (M5M5256BRV, 32K*8), or D1209 (HM628128AR, 128K*8). The RAM contains:

- bitplane data for the LCD picture
- text, to be used on the display
- data in RECORD mode
- data in A versus B mode (A= ↑ B= →)
- bitplane data used while making a printout of the screen

Ram Power circuit
The External RAM and the Standard RAM are powered by the RAM Power circuit. The RAM Power circuit is fed directly by the batteries, independently of the main power supply. Backup battery G1300 powers the RAMs if the batteries are removed. So no saved data (setups, waveforms, screens) will be lost then.
The RAM Power circuit is a simple oscillator, used to generate a stabilised voltage +VRAM out of the battery voltage -VBAT. The basic oscillator circuit is shown in figure 3.4.

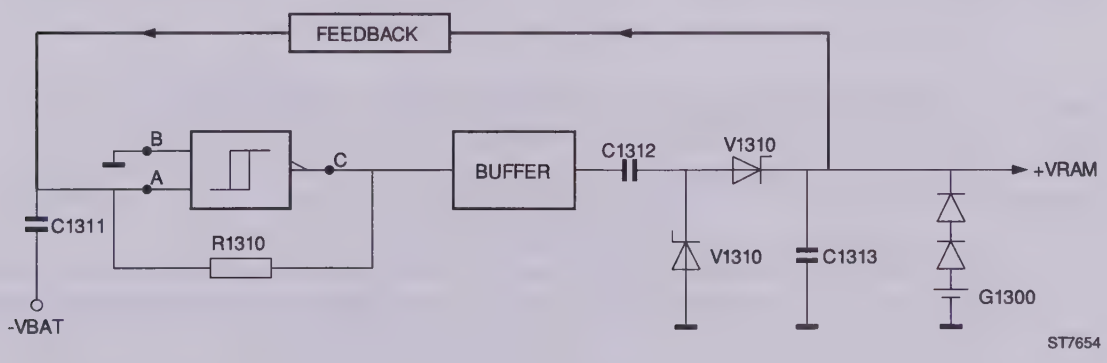


Figure 3.4 RAM Power circuit

Input B of Schmitt input NAND D1310 is connected to ground "high". When the voltage on input A is "low", the output C will be "high". Capacitor C1311 will charge via R1310. After some time input A will become "high", resulting in a "low" output C.

Capacitor C1311 will then discharge via resistor R1310. The generated output pulses are buffered and converted into a DC voltage by C1312, V1310 and C1313. The output voltage +VRAM is fed back to the NAND input A, via several transistors (voltage gap). If the output voltage +VRAM has reached the correct value, the pulse train at NAND output C is stopped via this feedback (see figure 3.6).

In this way capacitor C1313 is charged just enough to keep the output voltage +VRAM at a stable value (3V DC).

Figure 3.5 Pulse train signal on input A of Schmitt input NAND (Test Point 310)

3.3.5 LCD circuitry

- Introduction

The LCD used in the ScopeMeter test tool is controlled by six LCD driver integrated circuits. These drivers get their information (data- and control signals) from the D-ASIC. The microprocessor enables the display when valid data is present.

The test tool is provided with a transflective LCD with a backlight, which can be switched on or off by the user.

- Detailed circuit description

See figure circuit diagram A1 (figure 9.2).

LCD

The test tool uses a Super Twisted Nematic Liquid Crystal Display (LCD H1401, see circuit diagram A1, figure 9.2), with a resolution of 240 * 240 pixels.

The picture on the LCD screen is written column (vertical line) after column, rather than row (horizontal line) after row.

LCD drivers

The LCD display is controlled by the D-ASIC, via six LCD drivers:

- three LCD row drivers: D1404, D1405, D1406, each controlling 80 rows.
- three LCD column drivers: D1401, D1402, D1403, each controlling 80 columns.

Description of the LCD drivers input-/output signals:

LCD driver outputs Y1...Y80 and X1...X80

These outputs are connected to the LCD matrix. Every column driver serves 80 pixel columns of the LCD. Every row driver serves 80 pixel rows. The output signals are staircase signals, with levels equal to the V1...V6 voltages.

Data inputs D0... D3 (row drivers only!)
The actual display data coming from the D-ASIC is sent via the LCDCTL (LCD ConTroL) bus to the LCD drivers D0...D3 inputs. Data are provided via the lines:
- LCD1, LCD3, LCD1A, and LCD3A to D1404; D1404 controls the even numbered rows Y2...Y160.
- LCD0, LCD2, LCD0A, and LCD2A to D1405; D1405 controls the odd numbered rows Y1...Y159.
- LCD0, LCD1, LCD2, and LCD3 to D1406; D1406 controls the odd and even rows Y161...Y240.

The signals LCD0A...LCD3A are derived from LCD0...LCD3 by the odd/even circuit in the M-ASIC.

Terminal input voltages V1...V6
Out of the voltages V1...V6 the LCD drivers generate the staircase signals. The voltages are generated by the LCD SUPPLY circuit.

Display control signals LINECL, DATACL, DTCLA, M1, FRAME
These signals are used to control the LCD. The LCD picture is constructed from these display control signals and the data signals and sent to the LCD via the LCD driver outputs.
DATACL clocks the data into the driver buffer of D1406, DTCLA clocks the data into the driver buffers of D1404 and D1405.
The FRAME signal is the data signal for the column drivers D1401, D1402 and D1403.
LINECL clocks one complete line (column) into the LCD.
The M1 signal is described furtheron (see "M-randomize section" below).

LCD supply section
The pulse modulated signal, CONTR (contrast), comes from the D-ASIC. CONTR is filtered by R1430 and C1430 to get a DC voltage. The value of this voltage depends on the duty cycle of the CONTR signal. Via V1435, divider resistors R1420...R1424 and buffer opamps N1420, the CONTR signal controls the value of the voltages V1, V3, V4, V5 and V6. The LCD contrast depends on the value of these voltages.
As long as the signal LCDPWR, coming from the microprocessor, is "low" (0V), transistor V1435 does not conduct, and voltage V2 is approximately zero. As a result the LCD is blanked. After the microprocessor invokes a software reset, the LCDPWR line is made "high". Then V2 becomes approximately -20V.
The voltages V1...V6 are temperature corrected to compensate for the temperature dependency of the LCD (80 mV/°C). These voltages have to be corrected by the same amount to get a constant (over a temperature range) brightness and contrast of the LCD. This temperature compensation done by Positive Temperature Coefficient (PTC) resistor R1433. If the value of this resistor changes, also V2 changes. Voltage V2 is made out of the -30V voltage, coming from the Analog A2 PCB. Transistor V1432 limits the current through V1433 to approximately 30 mA. If the current exceeds 30 mA, the voltage drop across R1439 causes V1432 to start conducting.

M-Randomize section
The signal M ("LCD backplane modulation signal"), generated by the D-ASIC, has a time relation with the display control signals. The M-Randomize section in the M-ASIC converts M into M1, which is not time related to other display control signals. The M1 signal is used by the LCD drivers to convert all DC voltages into AC voltages without any DC component, able to drive the LCD. A DC component of the LCD drive voltage can cause memory effects on the LCD.

Backlight circuitry

Warning: The secondary voltage of the transformer T1442 is 1200 Vac peak-peak. This is the voltage on C1446 and the CCFL.

The combination V1445, V1448, transformer T1442, and capacitor C1445 is an oscillator. The frequency of the oscillator is approximately 70 kHz

The collector current Ic of V1441 on pin 2 of N1440 preliminary determines the intensity of the CCFL. N1440 compares the Ic with the current through the CCFL on pin 3 .
The output of N1440 on pin 16 is a switch to -Vbat, switching at a rate of approximately 200 kHz. The ratio of the current on pin 2 and 3 determines the duty cycle of this block. The duty cycle is a measure to control the average current to V1445 and V1448. L1442 converts the switched mode current to a DC current with a ripple.

When the CCFL is damaged and no CCFL is sensed at pin 3, the circuit around V14501 and V1451 will clamp the output voltage to a save level.
The signal on pin 6 of N1440 determines the CCFL is on or off.

3.3.6 M-ASIC

The M-ASIC D1210 contains a number of more or less independent circuits:

Address latch
The multiplexed Microprocessor AD bus (AD0...AD15) is supplied to the M-ASIC. The M-ASIC latches the address bits, and supplies them to the address outputs A00...A14.

Memory manager
The memory manager is a collection of circuits, mainly intended to control the ROM and RAM memories.

Keyboard scanner
The keyboard scanner consists of a row driver and a column read back circuit.
The row driver controls the keyboard rows after a switch has been pressed.
The column read back circuit reads the columns after the level at a row driver output has been changed.
Refer also to Section 3.3.3. "MICROPROCESSOR circuitry, keyboard circuitry".

Boot circuit
The boot circuit controls the Microprocessor EAN line. Refer to Section 3.3.3 "MICROPROCESSOR circuitry, RESET circuit" for detailed information.

Odd/even selection
This circuit cares that data for the even LCD lines Y2...Y160, and data for the odd LCD lines Y1...Y159, are supplied to respectively D1404 and D1405.

M-Randomize (AB-MIX)
The M-Randomize part generates the LCD backplane modulation signal M1. This signal M1 is de-synchronized from the other display control signals in order to prevent memory effects on the display. See also DISPLAY CONTROL SIGNALS.

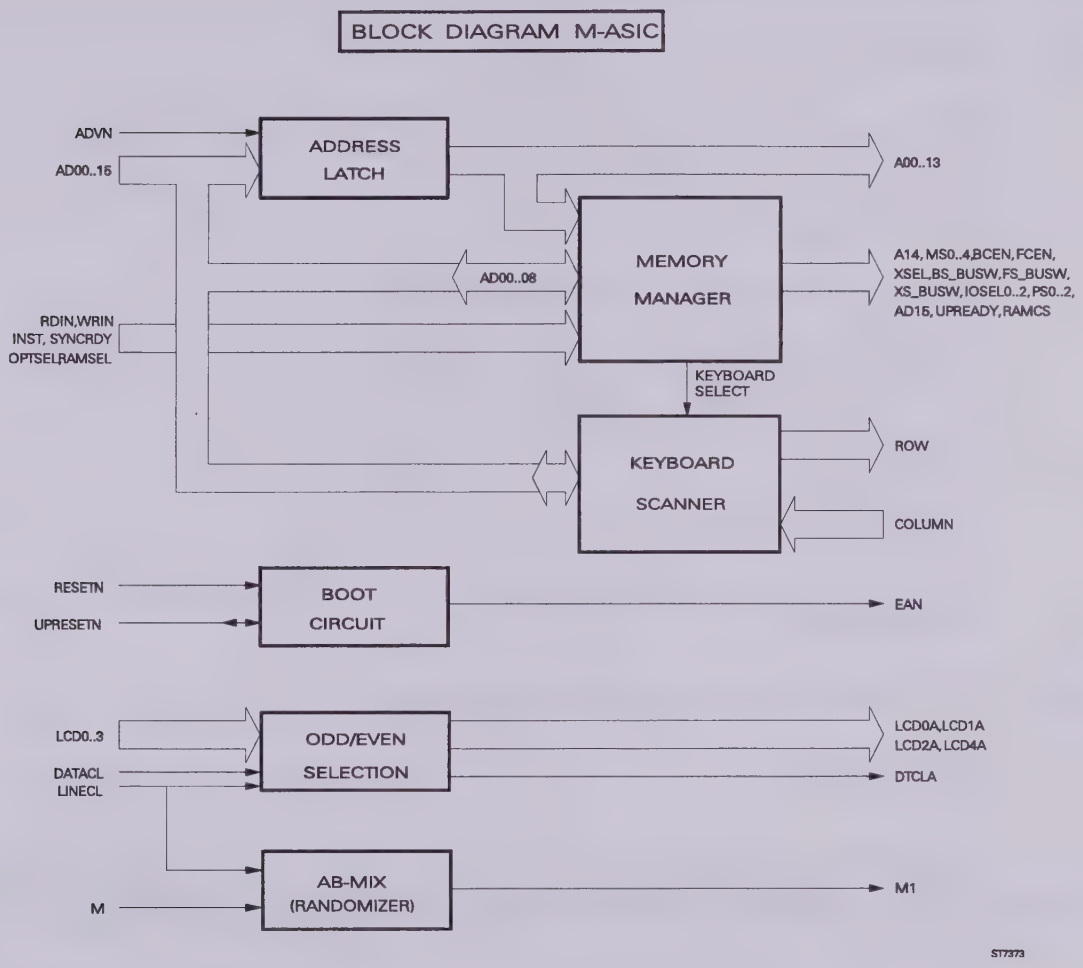


Figure 3.6 M-ASIC block diagram.

3.4 ANALOG CIRCUITS (A2)

3.4.1 Introduction

This paragraph describes the circuits on the analog A2 PCB in detail. Refer to circuit diagrams A2a, A2b, and A2c (figures 9.4a, 9.4b, and 9.4c in chapter 9).

3.4.2 Overview analog circuits

The analog A2 PCB contains several functional parts:

- circuits in the acquisition path
  - attenuator sections
  - EXTernal (banana) input/output circuitry
  - Analog ASIC and ADC circuitry
- control circuitry
- signal generator
- power supply and battery charger

Each of these parts will be described separately. First a short introduction is given, followed by a detailed description.

3.4.3 ATTENUATOR sections, CHANNEL A and B

- Introduction

See figure 3.7.

The attenuator sections of both channels A and B are identical. In the following only channel A is described. The corresponding components for channel B have the same numbering, except the second number, which is '1' instead of '2'. For example: R2202 in channel A corresponds with R2102 in channel B.

The attenuator section consists of a high frequency (here after referred to as H.F.) path and a low frequency (here after referred to as L.F.) path, which are combined again in the impedance converter (see figure 3.7). To get a flat frequency characteristic, both paths must overlap over a wide frequency range. Circuits are provided for automatic offset compensation.
The output of the attenuator sections of channel A and B is processed further by the A-ASIC.

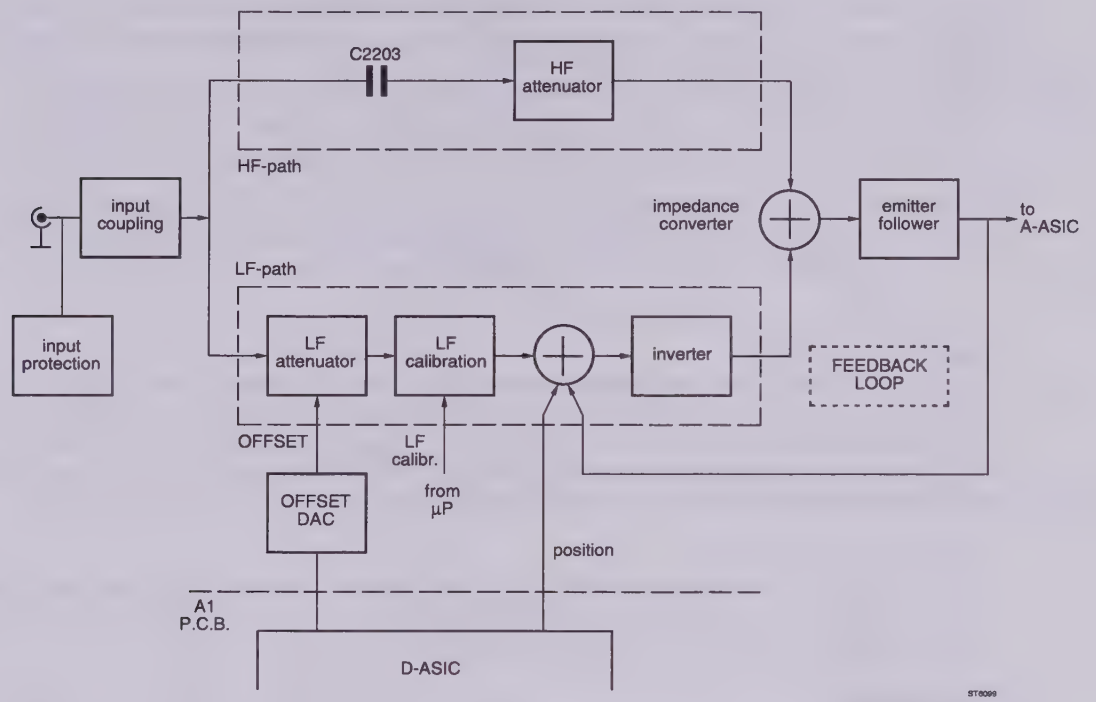


Figure 3.7 Schematic diagram attenuator section

- Detailed circuit description

See figure 3.7 and circuit diagram A2a (figure 9.4a).

Input coupling

The incoming signal first passes the AC/DC coupling section (C2202). When relay K2201 is opened, the signal is AC coupled via C2202.

H.F. (high frequency) path

After the coupling section, the L.F. part of the signal is blocked by capacitor C2203. Only the H.F. part of the input signal enters the H.F. attenuator. This is a triple capacitive divider, consisting of a 1 to 100, a 1 to 10, and a 1 to 1.48 divider.

The 1 to 1.48 divider section is switched on when relay switches K2202 and K2203 are in the "upper" position (as shown on circuit diagram A2a, figure 9.5).
The 1 to 1.48 divider consists of C2203 and C2209 in parallel with some parasitic capacitors. The attenuation of 1.48 times in this straight-on path is compensated for later in the circuitry.

The separate sections are switched in the signal path, depending on the attenuation required:

Table 3.2 Sections used in various attenuator settings

Attenuator Settings	Sections Used	Attenuation
5 mV/div 100 mV/div	1.48x	1.48 times
200 mV/div 1 V/div	1.48x, 10x	14.8 times
2 V/div 10 V/div	1.48x, 100x	148 times
20 V/div 100 V/div	1.48x, 10x, 100x	1480 times

In the ScopeMeter test tool the response of the H.F. attenuator sections is adjusted by means of three variable capacitors C2209, C2207 and C2114. These variable capacitors are used to compensate for parasitic capacitors of the printed circuit board.
The 1 to 1.48 divider (1 to 1.48 section) can be adjusted with variable capacitor C2209.
The 1 to 14.8 divider (1 to 1.48 and 1 to 10 sections) can be adjusted with variable capacitor C2207.
The 1 to 148 divider (1 to 1.48, 1 to 10 and 1 to 100 sections) can be adjusted with capacitor C2214.

NOTE: These capacitors do not have to be readjusted at every calibration. (see chapter 5, section 5.6.1) The capacitors are rough adjustments, used to compensate for hardware differences. The attenuator response is fine adjusted by means of the L.F. calibration section (see next page).

Impedance converter
The output of the H.F. path is connected with the impedance converter, formed by transistors V2207 and V2209 (see circuit diagram A2a, figure 9.4a). The bias voltage of V2207 is determined by R2216. To prevent destruction of the gate of V2207 by high voltages or voltage peaks, two clamps V2206 and V2204 are provided. Summation of the H.F. and the L.F. signal parts is obtained in transistor V2207, which acts as the collector impedance of V2208.

L.F. (Low frequency) path
The L.F. part of the input signal enters the L.F. path, which consists of a L.F. attenuator section, a L.F. calibration section and a regulating feedback loop, which consists of a summator, inverter, another summator, and an emitter follower (see figure 3.7).

L.F. attenuator
Fig 3.8 shows the L.F. attenuator section in detail:

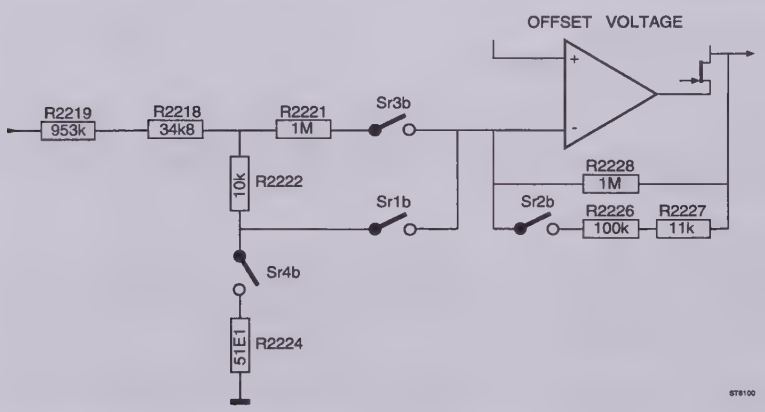


Figure 3.8 Principal diagram L.F. attenuator section

The L.F. attenuator consists of an inverting amplifier, N2201, which attenuates the L.F. signal by a factor, depending on the settings of switches D2201. These switches are controlled by signals named Sr1b...Sr4b. A "high" signal closes the corresponding switch.

Table 3.3 Attenuator drive signals Sr1b...Sr4b

Attenuator settings	Sr1b	Sr2b	Sr3b	Sr4b	Attenuation up to TP207	Attenuation up to TP204
5 mV/div...100 mV/div	high	low	low	low	1.48 times	1 time
200 mV/div...1 V/div	high	high	low	low	14.8 times	10 times
2 V/div...10 V/div	low	low	high	high	148 times	100 times
20 V/div...100 V/div	low	high	high	high	1480 times	1000 times

The attenuation of the LF CALIBRATION and FEEDBACK LOOP is about 1.48 times.

The signal Sr4b operates the switch, which is used to ground the L.F. part of the input signal during offset calibration. This is done automatically to prevent drift.

The offset DAC circuitry (see figure 3.7) provides the offset voltage for operational amplifier N2201. The offset compensation is done automatically by means of the signals So10b...So14b, coming from the D-ASIC.

L.F. Calibration

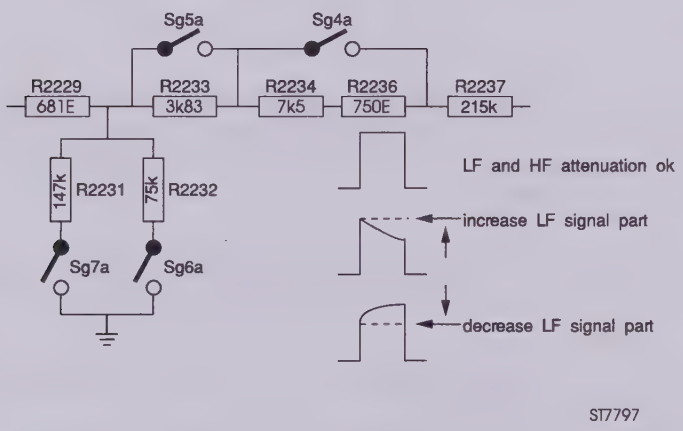


Figure 3.9 Automatic adjustment of the L.F. attenuation

Fine adjustment of the L.F. path attenuation is completed during calibration of the H.F. path attenuation. This is done by means of a simple 4-bits D-to-A converter, consisting of resistors R2229, R2231, R2232, R2233, R2234, R2236, and switches D2202. These switches are operated by signals Sg4a, Sg5a, Sg6a, and Sg7a, see figure 3.6. Resistors R2229, R2231 and R2232 divide the output signal of the attenuator section. Resistors R2233, R2234, and R2236 increase the input resistance of the inverting amplifier of the regulating loop.

Feedback loop

The output signal of the impedance converter is fed back to the input of operational amplifier N2201, with the signal coming from the L.F. calibration section (via R2237) and a DC position voltage (via R2248), proportional with the MOVEment of the trace (via R2248). Transistor V2210 is used to enlarge the dynamic range: when D-POSCHA is active, R2270 is incorporated in the circuitry.

The feedback loop operates as follows. If, for example, the output signal of the L.F. path is too small, the correction amplifier N2201 will drive V2207 via V2208. In this way the amplitude of the L.F. path and the position voltage are increased (compensation).

Input protection

The input protection safeguards the test tool against overvoltage. The input protection circuit consists of C2203 and V2206/V2204 (clamp HF attenuator) and R2219 and V2212/V2213 (clamp LF attenuator).

PTC resistors R2256/R2276 protect the test tool against accidental misuse, which involves applying voltage between the BNC input common and the black banana jack input common.

3.4.4 BANANA JACK INPUT/OUTPUT circuitry

- Introduction

See figure 3.10.

The ScopeMeter test tool is provided with two safety 4 mm banana jack inputs, which are used as inputs in the EXT mV, DIODE TEST, and OHM modes or as EXTernal trigger input in SCOPE mode. These banana jack inputs also serve as outputs for the built-in generator. Protection circuitry is provided to prevent damage by overvoltage.

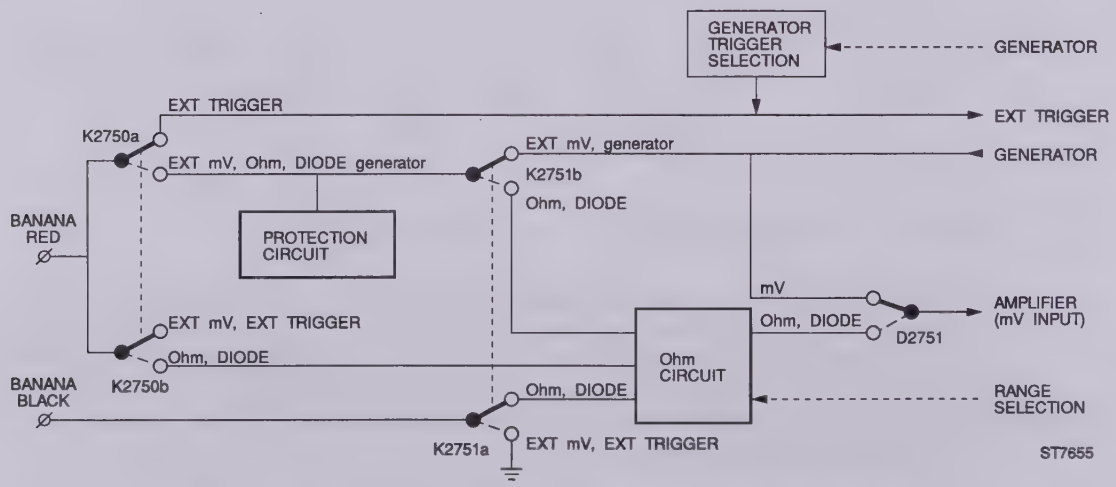


Figure 3.10 Schematic diagram signal flow in Banana jack input/output circuitry

- Detailed circuit description

See figure 3.10 and circuit diagram A2b (figure 9.4b).

EXT mV measurement circuitry

The EXT mV input voltage on the red banana jack input is fed to the L.F. part of the channel A attenuator section, via the following path: R2750, K2750a, K2751b, R2761, D2751 (refer to circuit diagram A2b, figure 9.6). When the test tool is switched to EXT mV measurement the settings are as follows:

Table 3.4 A-ASIC and attenuator settings in EXT mV mode

RANGE	A-ASIC (D2301)	LF-ATTENUATOR (channel A)
300 mV 3 V	100 mV/div 100 mV/div	1* 0.1*

Ohm measurement circuitry

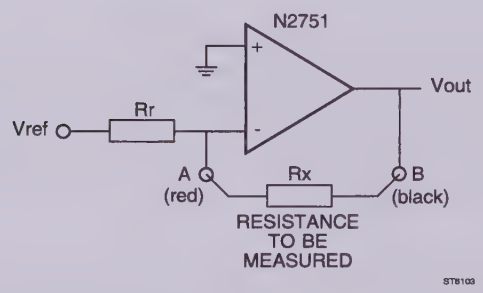


Figure 3.11 Ohm measurement circuitry (principle of operation)

The resistance R_x to be measured is connected as a feedback resistor of an amplifier circuit (opamps N2751). The output voltage of this measuring amplifier is proportional to resistance R_x:

$$V_{out} = (V_{ref}/R_r) \times R_x$$

The different ranges are obtained by selecting different values for resistor R_r . This can be done with the Ohm range selection circuit (D2750 and surrounding resistors), which is controlled by the Analog Control circuitry (circuit diagram A2a, figure 9.5, B-OFFSET lines).

Table 3.5 Ohm range selection circuit control lines

RANGE	Sc15	Sc16	Sc17	Sc18
300Ω	1	0	1	0
3kΩ	1	0	1	0
30kΩ	1	0	0	0
300kΩ	1	1	0	0
3MΩ	0	1	0	0
30MΩ	0	1	0	0

Switches D2751 choose between the EXT mV voltage and the voltage from the Ohm circuit. The outputs of these switches are connected to the L.F. part of the channel A attenuator (circuit diagram figure 9.3b).

Diode measurement circuitry
While in DIODE METER mode, the test tool uses the same circuitry as in the 300Ω range of the OHM mode.

WARNING: The BLACK banana jack input is not connected to the BNC grounds, while in OHM or DIODE METER mode! While in OHM er DIODE METER mode, the ScopeMeter test tool can not be grounded via the BLACK banana jack input.

EXTernal triggering
The trigger signal is fed to the A-ASIC on A2a figure 9.4a via resistor R2750 and voltage divider R2753/R2754 (see circuit diagram A2b, figure 9.4b). It is also possible to trigger on the signal made by the generator. Then the trigger signal is made out of the signals STIMUL and G-OUTP by D2850, V2758, and related components.

Generator signal
The output of the generator (see paragraph 3.4.7) is sent to the EXT banana jack inputs via K2751b, K2750a and R2750.

Protection circuit (generator mode)
If a high voltage is applied to the banana jack inputs A and B, a current will flow from input A, through PTC (Positive Temperature Coefficient) R2750, zener diodes V2750 or V2751 and via V2752 and V2753 back to input B (see circuit diagram A2b, figure 9.4b). The voltage across the zener diodes is limited to 7.5V for each diode. The rest of the input voltage is dropped across R2750. The resistance of this PTC will rise and limit the current in the circuit. Opamp N2750 drives V2752 and V2753, to prevent capacitive load of the generator by these zener diodes.

Protection (Ohm and diode measurement)
If a high voltage is put on the banana jack inputs, this results in an increase of the voltage over PTC R2750. This increases the value of this PTC, limiting the current in the circuit. Zener diode V2764 limits the output voltage of the measuring amplifier circuit N2751. Resistor R2771 and clamp diodes V2759...V2763 protect the input of the measuring amplifier.

3.4.5 ANALOG ASIC (A-ASIC) and ADC circuitry

- Introduction
See figure 3.12.

The signals coming from the channel A and B attenuators are fed to D2301. Various oscilloscope functions are integrated in this Application Specific Integrated Circuit (ASIC).
Analog ASIC D2301 selects the signal source and prepares the signal for further processing by the ADC circuitry. Also a trigger signal is derived from one of the channel A or B inputs or the external trigger input (banana connectors).

- Detailed circuit description
See figure 3.12 and circuit diagram A2a/A2b (figure 9.4a/9.4b).

First a short description is given for the internal circuits of the A-ASIC. The schematic diagram of the A-ASIC D2301 is shown in figure 3.12. The A-ASIC input/output signals are also described in the following sections.

Channel A Amplifier and Channel B Amplifier
The output signals of the channel A and B attenuator sections are amplified in the A-ASIC to obtain the most sensitive ranges.

Table 3.6 A-ASIC relative amplification at various attenuator settings

Attenuator setting:	A-ASICrelative amplification:
100 mV/div	1 time
50 mV/div	2 times
20 mV/div	5 times
10 mV/div	10 times
5 mV/div	20 times
2 mV/div*	10 times
1 mV/div*	20 times

(* both 1mV/div and 2 mV/div settings are made by multiplying times five and averaging the signal in 5 mV/div. and 10 mV/div.)

The standard gain of the A-Asic in 100 mV/div. is 2.6 times.
The A-ASIC itself can handle input signals with a maximum amplitude of 750 mV peak-peak. A vertical offset voltage YPOS is added to the signal in the attenuator sections (section 3.4.3). This means that 0V on an A- ASIC input terminal results in a trace in the vertical middle of the screen.

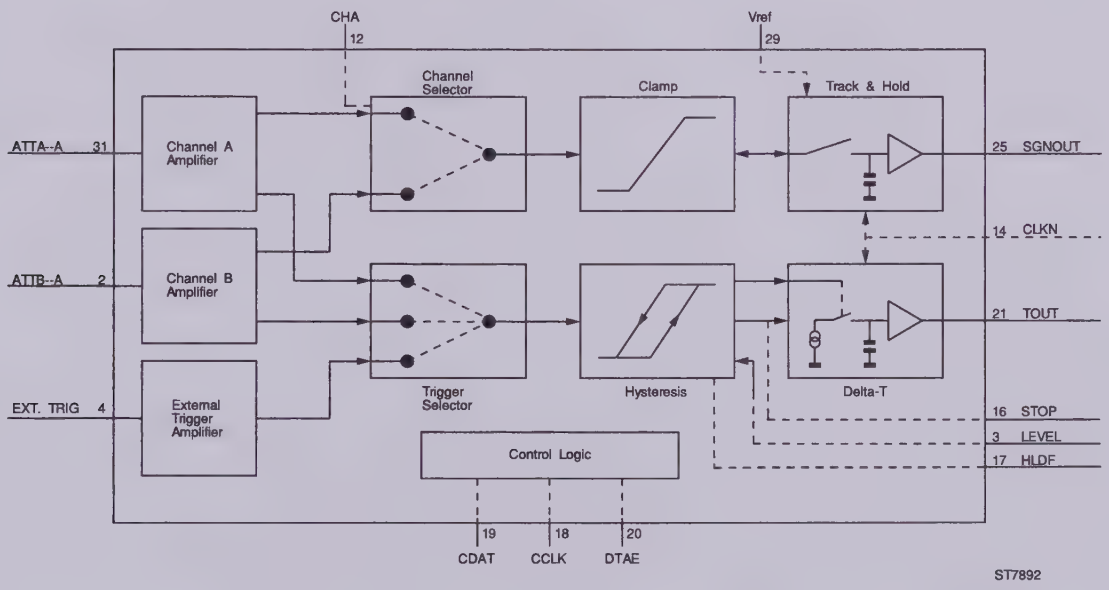


Figure 3.12 Schematic diagram A-ASIC D2301

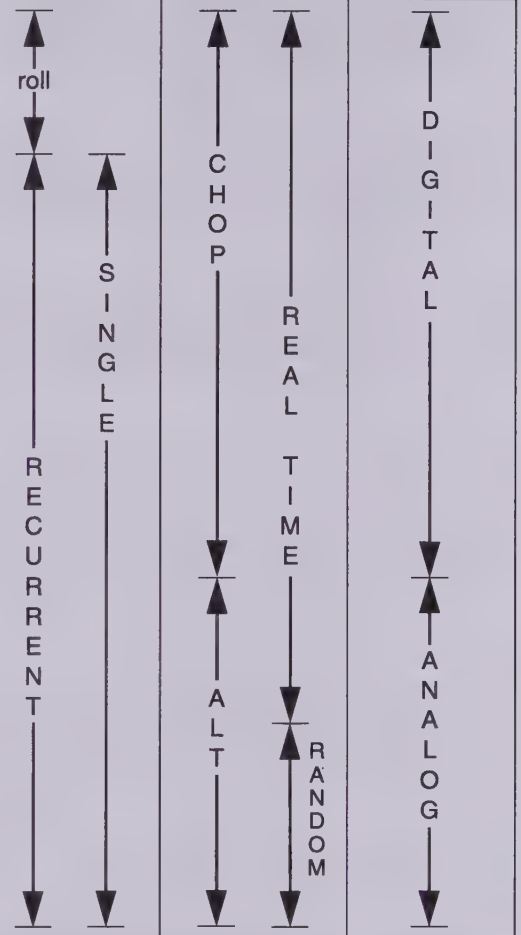
Channel Selector
The channel selector selects channel A or channel B, depending on the level of the CHANA signal (input 12).

If CHA is "high" (> 3.5 V) channel A is selected.
If CHA is "low" (< 1.5 V) channel B is selected.

If a timebase speed faster than 20 µs is selected, both channels are displayed in alternate mode and CHA is a square wave signal with a timebase-dependent frequency (see table 3.7). If a timebase speed slower than 50 µs is selected, both channels are displayed in chopped mode. The CHA signal is a square wave signal with a trigger-dependent frequency of 500 kHz maximum.

Table 3.7 Frequencies of A-ASIC signals in various modes

Time Base	TRACKN freq 1)	CHA freq 1)	MODE horizontal	MODE vertical	TRIGGER 2)
60 s/div	0.8333 Hz	0.416 Hz			
20 s/div	2.5 Hz	1.25 Hz			
10 s/div	5 Hz	2.5 Hz			
5 s/div	10 Hz	5 Hz			
2 s/div	25 Hz	12.5 Hz			
1 s/div	50 Hz	25 Hz			
.5 s/div	100 Hz	50 Hz			
.2 s/div	250 Hz	125 Hz			
.1 s/div	500 Hz	259 Hz			
50 ms/div	1 kHz	500 Hz			
20 ms/div	2.5 kHz	1.25 kHz			
10 ms/div	5 kHz	2.5 kHz			
5 ms/div	10 kHz	5 kHz			
2 ms/div	25 kHz	12.5 kHz			
1 ms/div	50 kHz	25 kHz			
.5 ms/div	100 kHz	50 kHz			
.2 ms/div	250 kHz	125 kHz			
.1 ms/div	500 kHz	250 kHz			
50 µs/div	1 MHz	500 kHz			
20 µs/div	1.25 MHz				
10 µs/div	2.5 MHz				
5 µs/div	5 MHz	Trigger			
2 µs/div	12.5 MHz				
1 µs/div	25 MHz	dependent			
.5 µs/div	25 MHz				
.2 µs/div	25 MHz				
.1 µs/div	25 MHz				
50 ns/div	25 MHz				
20 ns/div	25 MHz				
10 ns/div	25 MHz				
5 ns/div	25 MHz				



1) In MIN/MAX mode the frequency of CHA is zero and the sample frequency TRACK is always 25 MHz.
2) External triggering is always analog.

Output buffer

The DC bias level of the output signal is controlled by the Vref input. Vref assures, the signal is centered within the dynamic range of the ADC.

Track & Hold

The maximum sampling frequency of the ADC used in the ScopeMeter test tool is 25 MHz. Because of this a Track & Hold circuit is incorporated in the A-ASIC. The Track & Hold circuit determines the frequency range of the whole system.

The timing in this part of the A-ASIC is determined by clock signal TRACK (input 13). The frequency of the TRACKN signal depends on the selected timebase speed (see table 3.7).

The output signal, SGNOUT, (output 25) is fed to the ADC. The voltage range of SGNOUT is 1.5V...3.5V. The intermediate level of SGNOUT is derived from the VREF voltage level, which is made by the ADC.

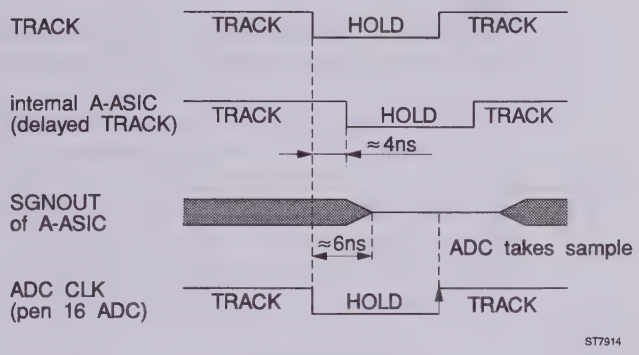


Figure 3.13 Track & Hold timing

External Trigger Amplifier

This amplifier section processes the incoming external trigger signal so that it can be used in the trigger section. The input of this section is TTL compatible in mode 1/10.

Trigger Selector

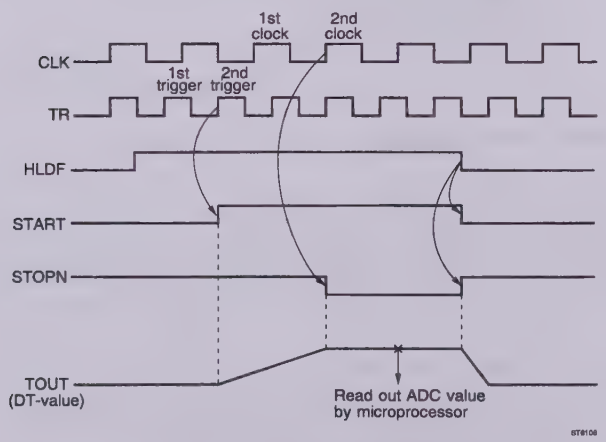
In this section the channel A, channel B or external trigger input signal is selected to act as trigger source. The trigger slope is also selected in this block.

Hysteresis

The hysteresis section converts the trigger signal into a pulse shaped signal. Because of the hysteresis, the circuit prevents false triggers on noisy signals. The LEVEL signal (input 3) that determines the trigger level, is a DC voltage approximately between +0.5V and +2.0V. The LEVEL signal is a DC voltage, generated in the Digital ASIC. Resistor R2309 and capacitors C2312 and C2313 form a lowpass filter, to convert a pulse width modulated signal into the DC voltage.

Delta-T circuit

The Delta-T circuit measures the time between a trigger pulse and the moment the input signal is sampled. Figure 3.14 shows the timing diagram with relation to the signal HLDF (input 17), START (internal), STOPN (output 16), and TOUT (output 21).



START: internal (in the A-ASIC) start signal for the Delta-T measurement.

TOUT: a voltage proportional to the measured value (time) of Delta T.

Figure 3.14 Timing diagram Delta-T circuit

Control logic

The control logic section contains a serial-in parallel-out shift register. This section gets its data from the microprocessor (D1201, circuit diagram A1, figure 9.2) via the CDAT (serial data), CCLK (serial clock), and DTAE (data-latch) lines. The control logic section controls all functional blocks within the A-ASIC.

ADC

The output signal SNGOUT (pin 25) of the A-ASIC is fed to the 8-bit Analog Digital Converter TDA 8703. This component operates on a 25 MHz clock signal.

The ADC provides for the reference voltage needed by the A-ASIC. This reference voltage is derived from the ADC. VREF is made of the voltages on pin 4 (VRB = Reference Bottom Voltage: +1.5V) and pen 9 (VRT = Reference Top Voltage: +3.5V) of the ADC. During normal operating conditions this reference voltage, VREF, is +2.5V (+/- 3.6%, ref. to ground). VREF is adjusted with potentiometer R2346, marked "OFFSET" and can be measured between TP331 and ground. The sensitivity of the ADC is adjusted with R2347, marked "GAIN". These calibrations are described in chapter 5, section 5.6.1: "Hardware SCOPE Calibration Adjustments".

The 8-bit output of the ADC: ADC0...ADC7 is connected to the Digital ASIC on the digital A1 PCB.

3.4.6 ANALOG CONTROL CIRCUIT

- Introduction

See figure 3.13.

The various sections of the ScopeMeter test tool, situated on the analog A2 PCB, are controlled by the microprocessor on the digital A1 PCB. This is done by means of the CCLK (serial clock), CDAT (serial data) and DTAE (data-latch) lines. This bus system creates several control signals, which for example drive the relays switches in the attenuator sections.

- Detailed circuit description

See figure 3.13 and circuit diagram A2a (figure 9.4a).

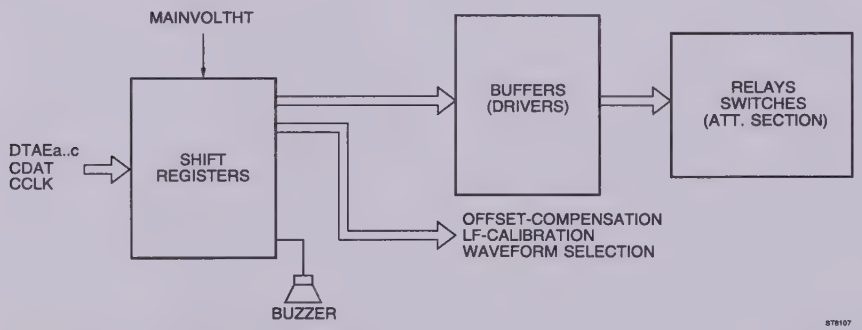


Figure 3.15 Schematic diagram analog control circuitry

Each shift register transforms the serial signal CDAT into 8 parallel control signals. This is done by means of the serial clock signal CCLK and the data-latch signals DTAEa, DTAEb and DTAEc. The control circuitry comprises two series of cascaded shift registers: D2907-D2908-D2909 (24 signals) and D2904- D2906(16 signals).

The signals, that are made by the shift registers, are used:

- to control the buffers (D2901 / D2902 / D2903), which drive the relays in the attenuator section.
- for offset compensation (A-RANGE and B-RANGE) in the attenuator sections.
- for L.F.-calibration (A-OFFSET and B-OFFSET) in the attenuator sections.
- to select the waveform in the signal generator section (sinewave/squarewave/DC).
- to drive the buzzer (beeper).

- Relay tables

In the following tables the number "1" means "high" (active) signal. "0" means "low" signal and "X" means "can be high or low (don't care)".

SCOPE mode INPUT B BNC, DC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
[1] 100 mV/div	1	0	0	x	x	x	x	0
[2] 1V/div	1	1	0	x	x	x	x	0
10V/div	1	0	1	x	x	x	x	0
100V/div	1	1	1	x	x	x	x	0
GROUND	0	1	1	x	x	x	x	0

SCOPE mode INPUT B BNC, AC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
100 mV/div	0	0	0	x	x	x	x	0
1V/div	0	1	0	x	x	x	x	0
10V/div	0	0	1	x	x	x	x	0
100V/div	0	1	1	x	x	x	x	0
GROUND	0	1	1	x	x	x	x	0

SCOPE mode INPUT A BNC, DC coupled

	K2101	K2102	K2103	K2201	K2203	K2203	K2750	K2751
100 mV/div	x	x	x	1	0	0	x	0
1V/div	x	x	x	1	1	0	x	0
10V/div	x	x	x	1	0	1	x	0
100V/div	x	x	x	1	1	1	x	0
GROUND	x	x	x	x	0	1	1	0

SCOPE mode INPUT A BNC, AC coupled

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
100 mV/div	x	x	x	0	0	0	x	0
1V/div	x	x	x	0	1	0	x	0
10V/div	x	x	x	0	0	1	x	0
100V/div	x	x	x	0	1	1	x	0
GROUND	x	x	x	x	0	1	1	0

[1] Relay information valid for SCOPE attenuator settings up to 100 mV/div.

[2] Relay information valid for SCOPE attenuator settings between 100 mV/div and 1V/div, etc.

SIGNAL GENERATOR, EXTERNAL TRIGGER (banana jack inputs)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
Ext. Trig	x	x	x	x	x	x	0	0
Generator	x	x	x	x	x	x	1	0

METER mode, V DC (INPUT A BNC)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	1	1	0	x	0
3V	0	1	1	1	0	1	x	0
30V	0	1	1	1	1	1	x	0
300V	0	1	1	1	1	1	x	0

METER mode, V AC (INPUT A BNC)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	0	1	0	x	0
3V	0	1	1	0	0	1	x	0
30V	0	1	1	0	1	1	x	0
300V	0	1	1	0	1	1	x	0

METER mode, V DC + AC (INPUT A BNC)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	1	1	0	x	0
3V	0	1	1	1	0	1	x	0
30V	0	1	1	1	1	1	x	0
300V	0	1	1	1	1	1	x	0

EXT mV mode (banana jacks inputs)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
300 mV	0	1	1	0	0	1	1	0
3V	0	1	1	0	0	1	1	0

OHM mode (banana jack inputs)

	K2101	K2102	K2103	K2201	K2202	K2203	K2750	K2751
30, 300 Ohm	0	1	1	0	0	1	1	1
3 KOhm	0	1	1	0	0	1	1	1
30 KOhm	0	1	1	0	0	1	1	1
300 KOhm	0	1	1	0	0	1	1	1
3 MOhm	0	1	1	0	0	1	1	1
30 MOhm	0	1	1	0	0	1	1	1

- Control lines tables

SCOPE mode INPUT B BNC, DC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	1	0	0	0	0	x	x	x	x	x	x	x
1V/div	1	1	0	0	0	x	x	x	x	x	x	x
10V/div	0	0	1	1	0	x	x	x	x	x	x	x
100V/div	0	1	1	1	0	x	x	x	x	x	x	x
GROUND	0	0	0	1	1	x	x	x	x	x	x	x

SCOPE mode INPUT B BNC, AC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	1	0	0	0	0	x	x	x	x	x	0	0
1V/div	1	1	0	0	0	x	x	x	x	x	0	0
10V/div	0	0	1	1	0	x	x	x	x	x	0	0
100V/div	0	1	1	1	0	x	x	x	x	x	0	0
GROUND	0	0	0	1	1	x	x	x	x	x	0	0

SCOPE mode INPUT A BNC

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	x	x	x	x	x	1	0	0	0	0	0	0
1V/div	x	x	x	x	x	1	1	0	0	0	0	0
10V/div	x	x	x	x	x	0	0	1	1	0	0	0
100V/div	x	x	x	x	x	0	1	1	1	0	0	0
GROUND	x	x	x	x	x	0	0	0	1	1	0	0

SCOPE mode INPUT A BNC, AC coupled

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
100 mV/div	x	x	x	x	x	1	0	0	0	0	0	0
1V/div	x	x	x	x	x	1	1	0	0	0	0	0
10V/div	x	x	x	x	x	0	0	1	1	0	0	0
100V/div	x	x	x	x	x	0	1	1	1	0	0	0
GROUND	x	x	x	x	x	0	0	0	1	1	0	0

METER mode, V DC (INPUT A BNC)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	1	1	0	0	0	0	0
3V	0	0	0	1	1	0	0	1	1	0	0	0
30V	0	0	0	1	1	0	1	1	1	0	0	0
300V	0	0	0	1	1	0	1	1	1	0	0	0

METER mode, V AC (INPUT A BNC)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	1	1	0	0	0	0	0
3V	0	0	0	1	1	0	0	1	1	0	0	0
30V	0	0	0	1	1	0	1	1	1	0	0	0
300V	0	0	0	1	1	0	1	1	1	0	0	0

METER mode, V DC + AC (INPUT A BNC)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	1	1	0	0	0	0	0
3V	0	0	0	1	1	0	0	1	1	0	0	0
30V	0	0	0	1	1	0	1	1	1	0	0	0
300V	0	0	0	1	1	0	1	1	1	0	0	0

EXT mV mode (banana jack inputs)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
300 mV	0	0	0	1	1	0	0	0	1	1	1	0
300V	0	0	0	1	1	0	1	0	1	1	1	0

OHM - DIODE TEST mode (banana jack inputs)

	Sr1a	Sr2a	Sr3a	Sr4a	Sgnd8b	Sr1b	Sr2b	Sr3b	Sr4b	Sgnd8a	mV	OHM
30, 300 Ohm	0	0	0	1	1	0	0	0	1	1	0	1
3 KOhm	0	0	0	1	1	0	0	0	1	1	0	1
30 KOhm	0	0	0	1	1	0	0	0	1	1	0	1
300 KOhm	0	0	0	1	1	0	0	0	1	1	0	1
3 MOhm	0	0	0	1	1	0	0	0	1	1	0	1
30 MOhm	0	0	0	1	1	0	1	0	1	1	0	1
Diode	0	0	0	1	1	0	1	0	1	1	0	1

	Sc15	Sc16	Sc17	Sc18
30, 300 Ohm	1	0	1	1
3 KOhm	1	0	1	0
30 KOhm	1	0	0	0
300 KOhm	1	1	0	0
3 MOhm	0	1	0	0
30 MOhm	0	1	0	0
Diode	1	0	1	1

	G_OUTP
Ext. Trig. Generator	0 1

	BUZ
Buzzer off Buzzer on	1 0

	SCOPE mode Attenuator settings		METER mode
	≥ 20 mV/div	≤ 10 mV/div	
D-POSCHA D-POSCHB	0 1	1 1	1 x

While the ScopeMeter test tool is operating in METER mode or when the instrument is calibrated, the signals Si, mV, OHM, Sr1b, Sr2b, Sr3b, Sr4b, and D_POSCHB can change ("high/low"). Signals Ex and Ey are used to switch the relays. Both signals are "high" when the relays are not operated.

Signals Sg4a, Sg5a, Sg6a, and Sg7a set the L.F. gain for channel A. Sg4b, Sg5b, Sg6b, and Sg7b set the L.F. gain for channel B. Sg4a (Sg4b) is the most significant bit (MSB), Sg7a (Sg7b) is the least significant bit (LSB).

Signals So10b, So11b, S012b, So13b, and So14b are used to set the offset compensation in the preamplifier circuits of channel A. Signals Sc15, Sc16, Sc17, Sc18, and S014a are used to set the offset compensation in the preamplifier circuits of channel B. S010b (Sc15) is the most significant bit (MSB), So14b (So14a) is the least significant bit (LSB).

3.4.7 SIGNAL GENERATOR circuit, COMPONENT TESTER circuit

- Introduction

The ScopeMeter test tool has a built-in signal generator, which can produce the following signals, used to adjust the probes:

- square wave voltage, amplitude: 5V peak-to-peak
  frequency: 1.95 kHz
- DC voltage 3V

Model 99 can also produce:

- sine wave voltages, amplitude: 1V peak-to-peak
  frequency: 976 Hz
- square wave voltages, amplitude: 5V peak-to-peak
  frequencies: 488 Hz, 976 Hz, 1.95 kHz
- slow ramp voltage, -2V...+2V
- slow ramp current, 0...+3mA

The signal generator uses a square wave voltage, coming from the D-ASIC to generate the various signals. The circuit consists of an operational amplifier, a fourth order filter, and a current source. The configuration can be changed by means of programmable switches to produce different output signals.

- Detailed circuit description

See figure 3.16 and circuit diagram A2b (figure 9.4b).

Figure 3.16 shows the basic generator circuitry:

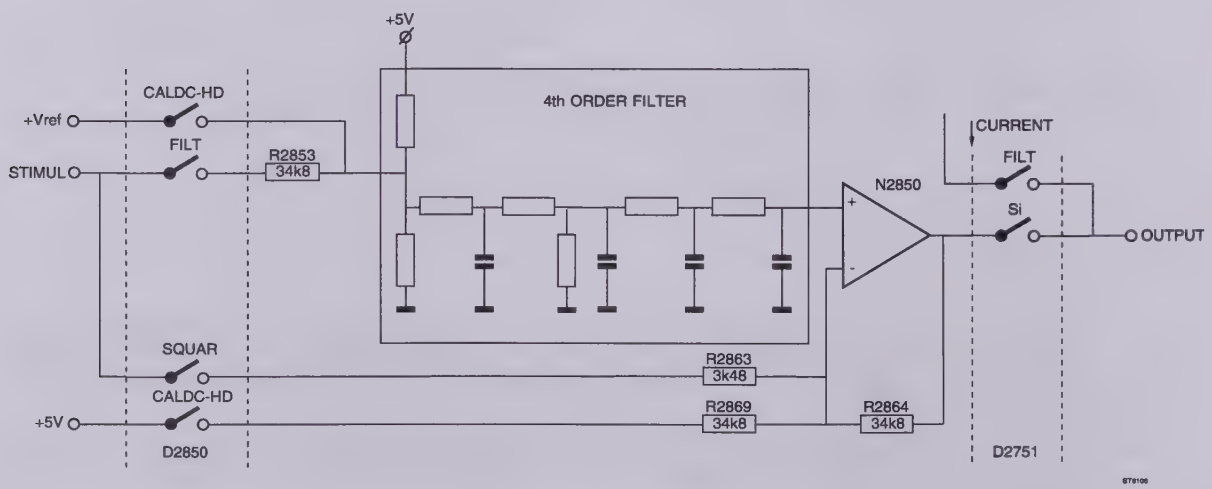


Figure 3.16 Basic generator circuitry

This circuit uses a square wave voltage, STIMUL, coming from the D-ASIC. This signal has an amplitude between 0V and +5V. The duty cycle of the square wave signal is varied depending on the signal to be generated. The reference voltage +Vref is used to generate the DC voltage.

The configuration depends on the settings of switches D2850 and D2751. These switches are controlled by the signals FILT, CALDC- HD, SQUAR and Si. Table 3.8 lists the various settings and resulting generator output signals.

Table 3.8 Generator control signals for various generator output signals

STIMUL		CONTROL SIGNALS				OUTPUT SIGNAL	
frequency	duty cycle	CALDC-HD	FILT	SQUAR	Si	amplitude	waveform
488 Hz 976 Hz 1.95 kHz	50% 50% 50%	0 0 0	0 0 0	1 1 1	1 1 1	5 V p-p 5 V p-p 5 V p-p	Square wave voltage
-	-	1	0	0	1	3 V p-p	DC voltage
976 Hz	50%	0	1	0	1	1 V p-p	Sine wave voltage
20 kHz	0-100%	0	1	0	1	-2...+2 V p-p	Slow ramp voltage
20 kHz	0-100%	0	1	0	0	0...+3 mA	Slow ramp current

In this table "1" means: signal "high" (switch closed) and "0" means signal "low" (switch open).

The slow ramp current signal is made with a current source. A simplified schematic diagram is given in figure 3.17:

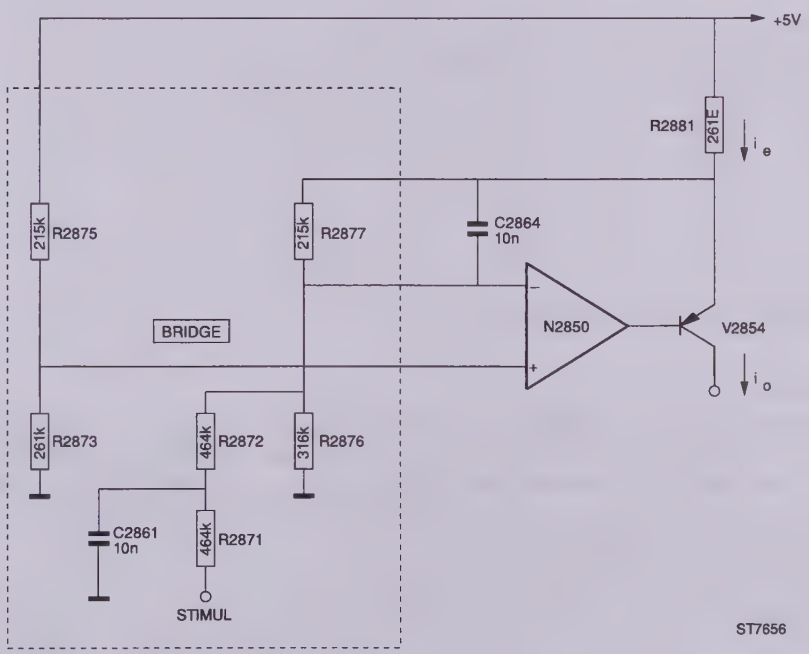


Figure 3.17 Current source section of generator

When the duty cycle of STIMUL is 0%, the bridge will be in balance and current $i_e = 0$. When the duty cycle of STIMUL is increased, a DC component is generated, which has a linear relation to the duty cycle. The operational amplifier tries to keep the voltages on both inputs the same. The operational amplifier will now drive transistor V2854 to increase i_e. Because i_e is almost equal to i_o, the output current will also increase. In this way it is possible to regulate the current i_o by means of the duty cycle of STIMUL.

3.4.8 BATTERY CHARGER

- Introduction

See figure 3.18.

The battery charger consists of a switched mode power supply and some auxiliary circuitry. Whenever the ScopeMeter test tool is connected to the line voltage (via the separate power adapter/battery charger PM8907), the instrument switches over to line voltage operation automatically. If a NiCd battery pack is installed, the test tool will charge this if line voltage is present. Special circuitry prevents discharge of the batteries when the instrument is not being used.

- Detailed circuit description

See figure 3.18 and circuit diagram A2c (figure 9.4c).

HF Filter

The input voltage (between 8V and 20V) first passes HF FILTER Z2501 and is used to drive a flyback converter.

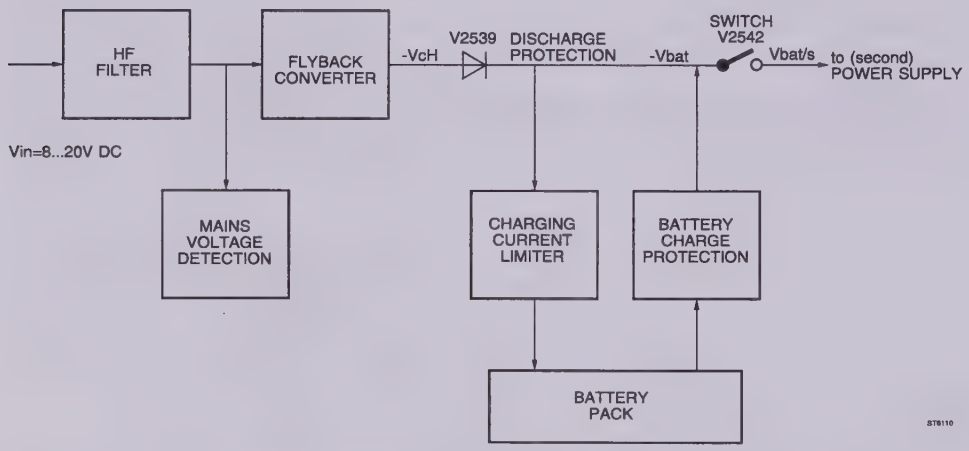


Figure 3.18 Schematic diagram battery charger

Line voltage detection

When the ScopeMeter test tool is operated on line voltage, transistor V2521 will be driven by the (filtered) input voltage. The signal MAINVOLTHT will become "low" to indicate that the test tool is operated from the line voltage. The related signal MAINS-D (connector X1201, pin 5) is connected to the microprocessor analog input 19. When the signal MAINS-D is "high", the microprocessor will not switch off the test tool , as in battery operated mode.

Flyback converter

See figure 3.19 and circuit diagram A2c (figure 9.4c).
The main components of this flyback converter are V2532 (converter-switch), L2504 and L2506 (windings), R2582 (sense resistor), and C2536 and V2533 (secondary circuit). The main regulating element is N2503 (see figure 3.19).

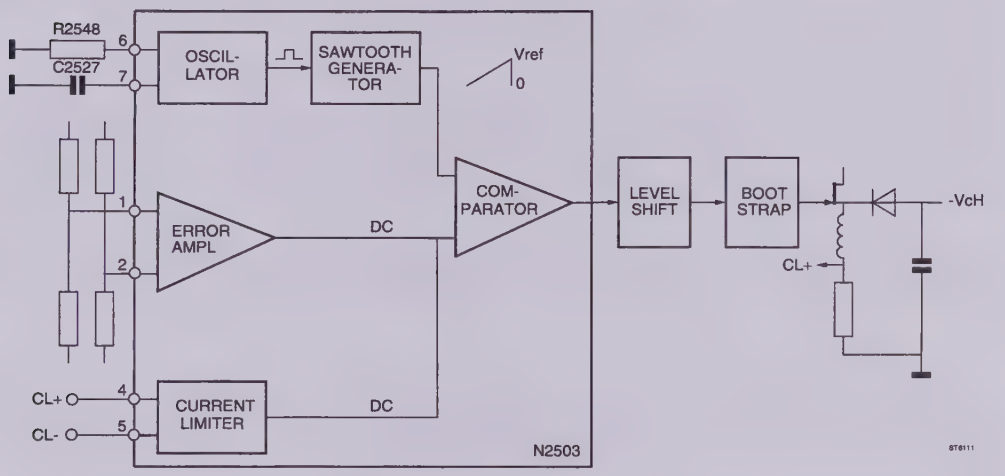


Figure 3.19 Schematic diagram flyback converter

N2503 incorporates an oscillator, the frequency of which is determined by R2548 and C2527 (fixed frequency of 100 kHz). This oscillator drives a sawtooth generator. The produced sawtooth voltage is compared to a DC voltage. This DC voltage is made by an internal error amplifier (voltage regulator), which compares the produced converter voltage -V_CH to a stable 5V reference voltage. This is done with a bridge circuit (R2554, R2555, R2557, R2558).

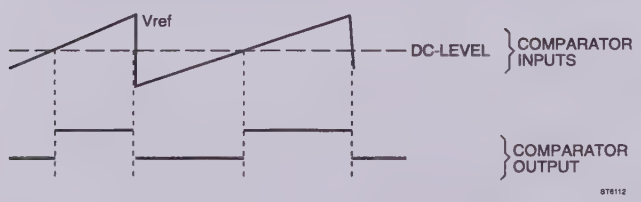


Figure 3.20 Internal N2503 voltage waveforms

When the sawtooth voltage is larger than the DC voltage, the output signal (CA, CB on pins 12,13) is "high". When the sawtooth voltage is less than the DC voltage, the output signal is "low". In this way the duty cycle of N2503's output signal can be changed, thus changing the energy transferred to the secondary converter circuit.

The output signal is level shifted by transistor V2526 and related circuitry. Now this square wave signal is used to drive converter switch V2532, which is bootstrapped via V2528, V2529, R2546, R2562, and C2537.

Charging current limiter

N2503 limits the voltage difference between CL+ (pin 4) and CL- (pin 5) to 200 mV. If the voltage between these two inputs starts to rise, the internal DC voltage will rise, and the duty cycle of the output square wave voltage will decrease (see voltage regulation described earlier).

If the ScopeMeter test tool is connected to the line voltage and is not operational, the flyback converter operates almost without a load (only the NiCd battery pack). This implies that the current floating through windings L2504 and L2505 (averaged in time) is almost zero. Because of this, the voltage on CL+ is about 30 mV and the voltage on CL- is about 170 mV. The battery pack will be charged with 170 mA.

If the flyback converter is operated normally (ScopeMeter test tool "ON"), the voltage on both CL- and CL+ will rise and the charging current will decrease to 100 mA.

Battery charge protection
To prevent charging of non-rechargeable batteries, a special protection circuit is provided. For safety reasons, this circuit consists of two cascaded sections. When the test tool is "ON", the flyback converter will be operative. The produced voltage POWER-ON will drive both Field Effect Transistors V2537 and V2538 open (conductive) via R2568 and R2569. Now the battery plus contact is connected to the test tool circuit ground. If line voltage is present, the voltage -VCH produced by the flyback converter will drive V2534 and V2536, which prevent transistors V2537 and V2538 from conducting. The battery plus contact is disconnected from ground.

Power ON/OFF circuitry
During normal operation the POWER-ON signal is +5V. Transistor V2542 is opened (conductive), so -Vbat/s equals -V_CH. If the test tool is operating and the RESPOWHT ("reset power supply") becomes "high", V2541 will conduct and V4542 will stop conducting. This will disconnect -Vbat/s from -V_CH.

3.4.9 POWER SUPPLY

- Introduction
See figure 3.21.

Different supply voltages are needed for various ScopeMeter test tool sections. A second flyback converter is used to convert -Vbat/s to supply voltages of -30V, -5V and +5V. This voltage, -Vbat/s, is made by the first flyback converter (in the battery charger section) or comes from the batteries. -Vbat/s is 5V if operated with NiCad battery pack, and 8V if operated from line voltage.

- Detailed circuit description
See figure 3.21 and circuit diagram A2c (figure 9.4c).

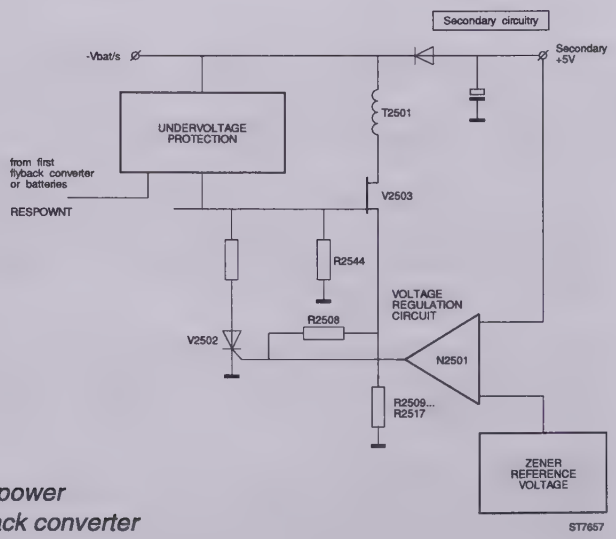


Figure 3.21 Schematic diagram power supply, second flyback converter

This self-oscillating flyback converter consists of:
- V2503 (converter-switch)
- R2509...R2517 (sense-resistors)
- V2502 (thyristor switch)
- R2544 (start-up resistor)
- T2501 (windings)
- 3 separate secondary circuits for -30V, -5V, and +5V

The main regulating component is operational amplifier N2501. This op-amp compares the produced secondary +5V voltage with a reference voltage, produced by zener diode N2502. If the secondary +5V increases, the fault signal generated by the N2501 will produce a current that causes an extra voltage drop over R2508. Because of this, thyristor V2502 will fire earlier. The switching frequency of the flyback converter increases and the secondary +5 V voltage decreases.

When the ScopeMeter test tool is switched on (RSSLSTN is "active low"), V2544 (see circuit diagram A2c, figure 9.6) connects the inverting input of N2501 to ground. When the ScopeMeter test tool starts up, capacitor C2509 causes the reference voltage and therefore the output voltage, to rise slowly, limiting the inrush ("starting") current drawn from the batteries or line voltage.

Undervoltage detection and protection circuit
When the flyback converter is oscillating, capacitor C2532 is charged every period via R2543 and V2516. During normal operation C2532 is discharged by V2517, which is driven via R2541, V2511, R2529, and V2509. If, for example, the secondary +5V voltage becomes too low, C2532 is not discharged by V2517. This will activate the RESPOWHT signal, and the power will be switched off completely, preventing further damage of circuits. (The +5V voltage can become too low because the input voltage -Vbat/s is too low, or the power output to the ScopeMeter test tool circuitry is too high.)

R2542, C2531, and diode V2508 will reset C2532 during the start up of the power supply (the voltage across C2532 will become zero). This is necessary because V2517 cannot be driven via V2541, just after the ScopeMeter test tool is switched on.

Reference source
The reference source provides a stable positive (+Vref) and negative reference voltage (-Vref) used in other parts of the ScopeMeter test tool. It also uses the voltage across zener diode N2502 as an input voltage.

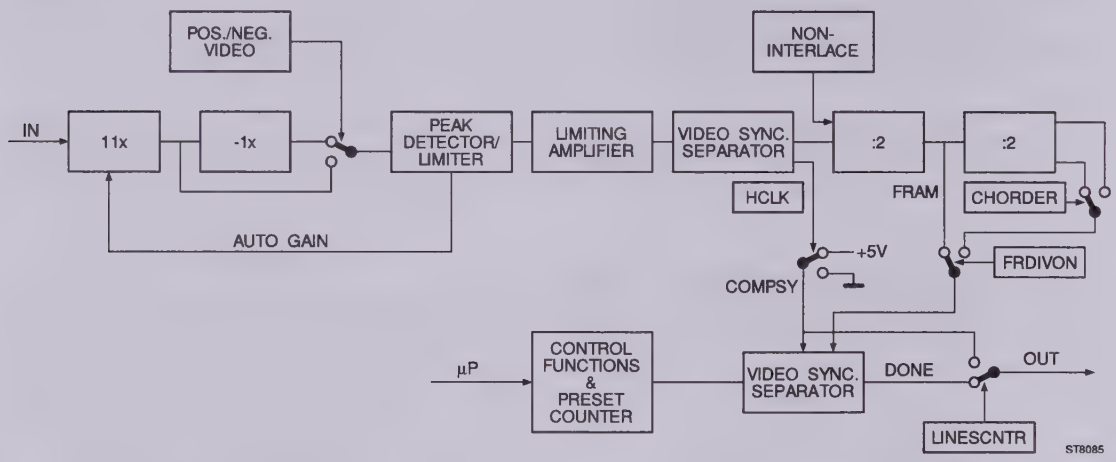
NOTE: The flyback converter, used in the battery charger section (section 3.4.8) has a fixed oscillating frequency of 100 kHz. The amount of energy supplied is regulated by varying the duty cycle. The flyback converter used in this power supply, however, is self-oscillating and operates on a variable oscillating frequency and a fixed duty cycle. For alkaline batteries, for example, the oscillating frequency is about 62 kHz.

3.5 TV TRIGGER A3

3.5.1 Introduction

The following paragraphs describe the TV Trigger A3 PCB. Refer to circuit diagram figure 9.5 and the block diagram.

3.5.2 Description block/circuit diagram



The input signal is coming from the output of the attenuator of channel A on the A2 PCB. The AC-coupled input signal will first be amplified. Depending on the video is positive or negative, the signal goes direct or via the -1 amplifier to the peak detector circuit. The peak detector is the circuit around V3001 and V3002. C3002 will be loaded to the peak DC voltage of the negative sync pulse. Via a limiting amplifier circuit, V3040, V3041 and a source follower, V3003, the video is AC-coupled to the video sync separator N3002. A small signal will pass and of large signals only the sync pulse can pass. The first flip-flop, D3001 has the following functions:

- blocking the video signal when TVON is "1" (normal trigger mode).
- blocking the Odd/Even signal when NONINTERlace is "1". Then the VCLK (Vertical CLocK) signal will be divided by 2.
- in the interlaced mode during low of Odd/even pin 9 (signal FRAMe) will be "1". The VCLK will make pin 9 "0".

The negative going of FRAM will force the output, pin 9 of D3008 to "1". The "1" will reset counter D3006. This is the start of a new cycle.

To trigger on a certain line, the counter will be preset by the mP. The COMPositeSYnc signal is the clock signal for the counter. When the counter reaches the preset value, the signal DONE will be generated on the output of the counter. The signal LINESCouNTeR selects DONE as the trigger signal for the ScopeMeter®.

Also DONE will change the output of D3008 so a new negative edge of FRAMe can start a new cycle. In the LINES mode the signal LINESCNTR selects COMPSY as the trigger signal for the ScopeMeter®.
In the four field sequence the signal FRameDIVideON selects the output of the second divide by two flip-flip as start signal for the counter.

The signal CHORDER selects between the first two fields or the second two fields.

4 PERFORMANCE VERIFICATION PROCEDURE

4.1 GENERAL INFORMATION

The ScopeMeter test tool should be calibrated and in operating condition when you receive it.

The following performance tests are provided to ensure that the test tool is in a proper operating condition. If the instrument fails any of the performance tests, calibration adjustments (see chapter 5) and/or repair (see chapter 7) is necessary.

The Performance Verification Procedure described here consists of two parts:

- Standard Performance Verification Procedure (separate SCOPE- and METER-section)
- Additional Performance Verification Procedure

The **Standard Performance Verification Procedure** uses built-in front panel settings or frontsettings, that can be accessed via the SERVICE MENU. To enter the SERVICE MENU, press the backlight key, then press AUTOSET, and then release the backlight key. This menu allows you to choose between SCOPE and METER performance testing ("Verify").

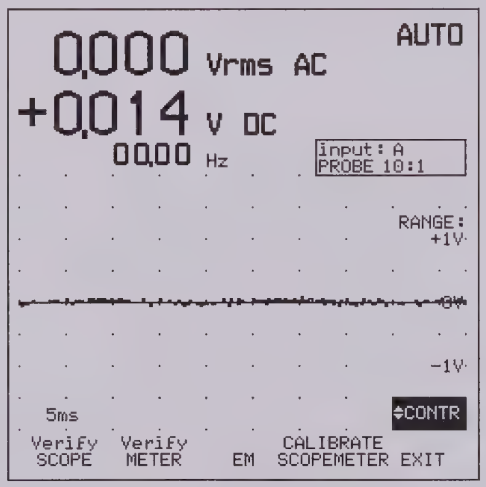


Figure 4.1 Service menu (entered from METER mode)

When the ScopeMeter test tool is in SERVICE mode, only the function keys (F1 .. F5), the UP/DOWN keys (△ ▽) and the ON/OFF key (ON/OFF) can be used.
It is possible to move forward or backward through the frontsettings, that apply to the separate performance test steps. This can be done using the UP/DOWN keys. You can leave the Performance Verification Procedure any time by pressing function key F5. The Performance Verification Procedure steps are explained in the following sections.

The **Additional Performance Verification Procedure** can be used to do some extra checks, depending on the ScopeMeter test tool version. In these tests the ScopeMeter test tool must be set up manually.

NOTE: This Performance Verification Procedure is a quick way to check most of the instrument's specifications. Because of the highly integrated design of the ScopeMeter test tool, it is not always necessary to check all features separately. The procedure described here often combines many test steps in one procedure step, thereby minimizing total test time.

The Performance Verification Procedure is based on the specifications, listed in chapter 2 of this Service Manual. The values (requirements) given here are valid for ambient temperatures between 18 °C and 28 °C.

4.2 STANDARD PERFORMANCE VERIFICATION PROCEDURE

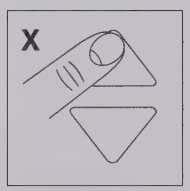
This section explains the required Performance Verification Procedure setup, with the actions that have to be done for each step. Follow the instructions described with each step.
The recommended test equipment, required for this Standard Performance Verification Procedure, is listed in table 4.1.

Table 4.1 Recommended test equipment Standard Performance Verification Procedure

Instrument Type	Recommended Model
Multifunction Calibrator	Fluke 5100B
Function Generator	Philips PM 5134
Time Mark Generator	Tektronix TG 501
Constant Amplitude Sine wave Generator	Tektronix SG 503
Square wave Calibration Generator	Tektronix PG 506
TV Signal Generator	PM5418

- Cables and terminations for the generators (all BNC type)
- Two standard banana test leads (delivered with the ScopeMeter test tool)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter test tool)

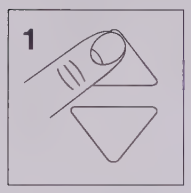
NOTE: During the following Performance Verification Procedure, the ScopeMeter test tool inputs are connected to the signal generator outputs by means of coaxial cables (INPUT A or B BNC) or two standard banana test leads (banana jack inputs). The oscilloscope probes delivered with the instrument are not used during the Standard Performance Verification Procedure. The calibration of the probes is described in the Users Manual.



In the following text, this figure is used to indicate that one of the UP key (△) or the DOWN key (▽) must be pressed, to display the indicated step number "x".

1/2. LCD test

While in the SERVICE menu, press the SCOPE function key to enter the **SCOPE section of the Performance Verification Procedure**.



Now a (dark) test pattern is displayed. This pattern consists of a circle placed in a square, and three diagonal lines (see figure 4.2).

Observe the test pattern closely. The lines may not be interrupted; the pattern must be continuous. In this test sets the display to a high contrast, resulting in a dark display. If there are defects in the pixel columns of the Liquid Crystal Display, they must be clearly visible now as intermissions in the pattern.

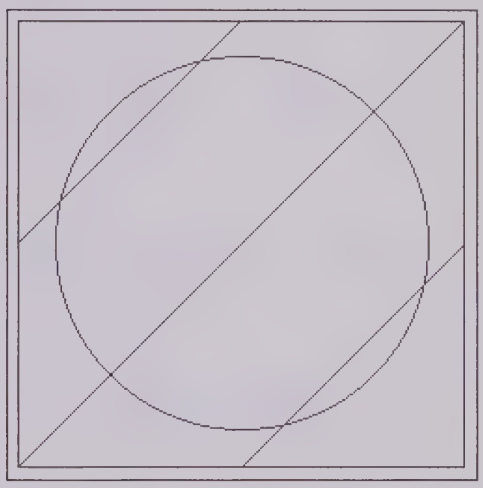
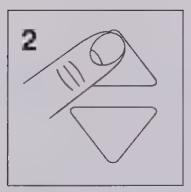
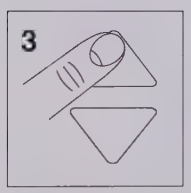


Figure 4.2 Test pattern



Press the UP key again to go to step 2. Now the display shows the same pattern, but with a low contrast (bright display). This will help you to locate any failures in the pixel rows of the LCD.

3. Ground level check



Press the UP key to go to step 3. The purpose of this step is to check the ground level position adjustments (0V) for both traces. The display shows the text " Verif 3", to show that this is the third SCOPE Performance Verification step (see figure 4.3).

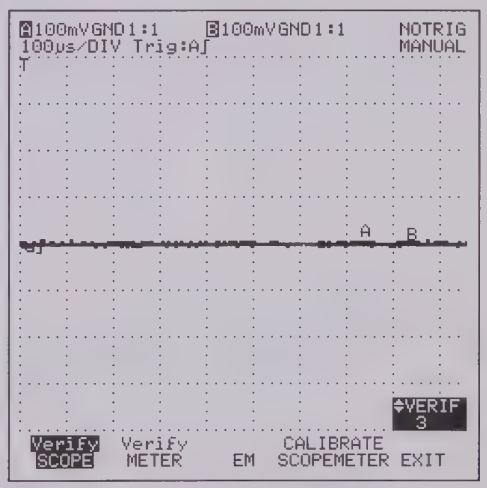
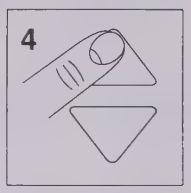


Figure 4.3 Reference set-up

Requirements:

Verify that the traces of both channels A and B are situated on the vertical middle of the screen.

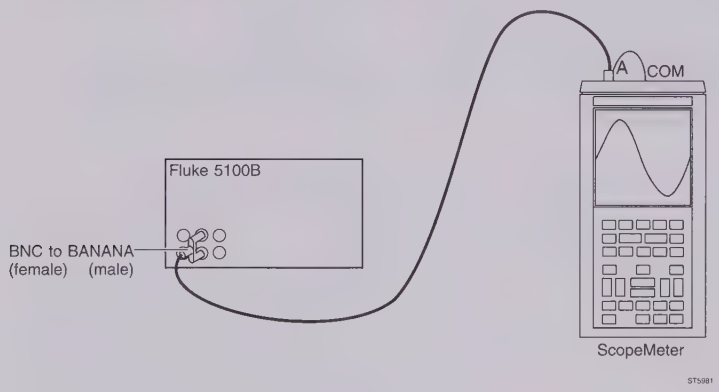
4. Vertical deflection coefficients channel A



These tests check the vertical deflection coefficients for channel A in the 100 mV/div AC range.

Test equipment:
Fluke 5100B Calibrator

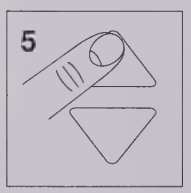
Test setup:
Connect the banana jack COM to the BNC common



Procedure/requirements for AC test:

A Apply a 1 kHz sine wave signal with an amplitude of 600 mV AC peak-to-peak to the INPUT A BNC.
(Set the Fluke 5100B to 212.13 mV RMS, 1 kHz sine wave).
Verify that the amplitude of the sine wave signal displayed is 5.88...6.12 divisions.

5/6/7. Vertical deflection coefficients channel B

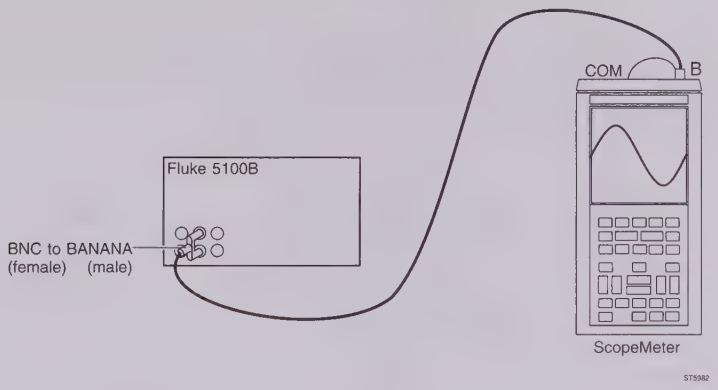


These tests check the vertical deflection coefficients for channel B in the AC ranges.

Test equipment:
Fluke 5100B Calibrator

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements for channel B AC tests:

Apply the input voltage and the setting of channel B according to table 4.2 and check that the amplitude of the signal agrees with the value listed. Use the UP/DOWN keys to select each step number.

NOTE: The AC voltages listed in this are peak-to-peak voltages (sine wave). The values listed between brackets () are the RMS values that have to be chosen on the Fluke 5100B calibrator.

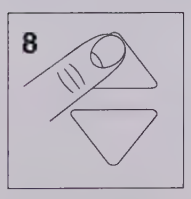
Requirements:

Table 4.2 Requirements vertical deflection coefficients for channel B

Input voltage	Step number on display	Requirements
600 mV AC pp (212.13mV RMS), 1 kHz	"5"	5.88...6.12 div.
6V AC pp (2.1213V RMS), 1 kHz	"6"	5.88...6.12 div.
60V AC (21.213 V RMS), 1 kHz	"7"	5.88...6.12 div.

The ScopeMeter test tool uses the same input circuitry (hardware) for the SCOPE and the METER modes (in the above attenuator settings). When the voltage accuracy is checked (see the description "METER Performance Verification Procedure" step 1), the deflection coefficients for SCOPE channel A are also tested.

8/9. Rise time



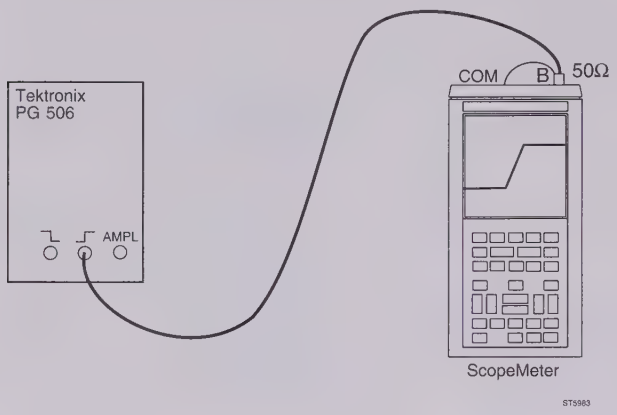
The rise time of the test tool is checked by means of a fast rise time pulse. First channel B is measured.

Test equipment:

Tektronix PG 506 Square Wave Calibration Generator

Test setup channel B rise time measurement:

Connect the banana jack COM to the BNC common



Procedure for channel B rise time measurement:

A Apply a fast rise time pulse, repetition frequency 1 MHz, amplitude 0.5V to the INPUT B BNC. Use a 50Ω termination. Set the generator in position "FAST RISE".

B Adjust the pulse amplitude to exactly 5 divisions. See figure 4.4.

Requirements:

C Check the rise time, measured between 10% and 90% of the pulse amplitude. See figure 4.4. The rise time t_r (measured) must be 5.8 ns for the Fluke 92B, 96B or 3.5 ns for the Fluke 99B, 105B.

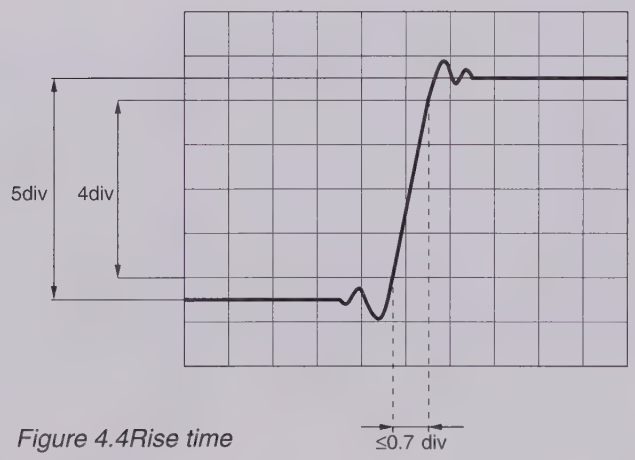
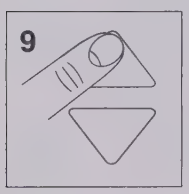


Figure 4.4Rise time

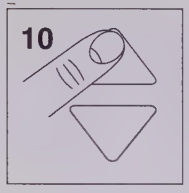


Test setup channel A rise time measurement:
Refer to the test set-up for channel B measurement. Connect the pulse generator to the INPUT A BNC.

Procedure for channel A rise time measurement:
Refer to the settings/procedure for channel B measurement.

Requirements:
Refer to channel B requirements.

10/11/12/13. Frequency response



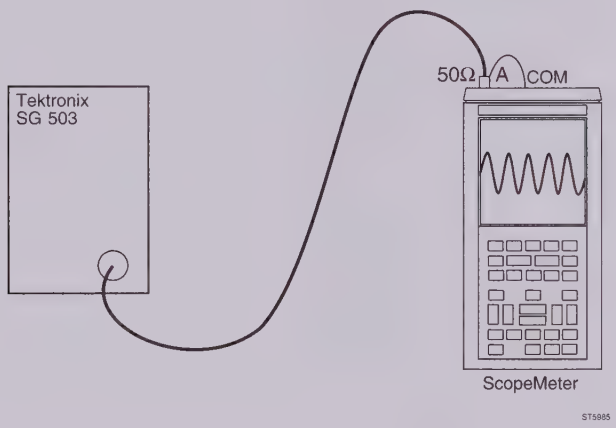
These tests check the upper transition point of the bandwidth for channels A and B.

Test equipment:

Tektronix SG 503 Constant Amplitude Sine wave Generator

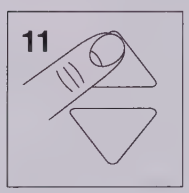
Test setup:

Connect the banana jack COM to the BNC common



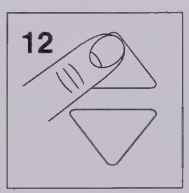
Procedure/requirements for channel A frequency response measurement:

A Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to the INPUT A BNC. Use a 50Ω termination. Adjust the input signal to a trace height of exactly 6 divisions.



B Without changing the amplitude of the sine wave signal, switch over to step 11 using the UP key. Increase the frequency of the sine wave to 60 MHz for the Fluke 92B, 96B or 100 MHz for the Fluke 99B, 105B and verify that the vertical deflection is 4.2 divisions or more.

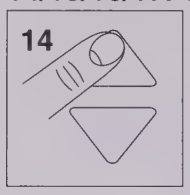
Procedure/requirements for channel B frequency response measurement:



C Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to the INPUT B BNC. Use a 50Ω termination.
Adjust the input signal to a trace height of exactly 6 divisions.

D Without changing the amplitude of the sine wave signal, switch over to step 13 using the UP key. Increase the frequency of the sine wave to 60 MHz for the Fluke 92B, 96B or 100 MHz for the Fluke 99B, 105B and check that the vertical deflection is 4.2 divisions or more.

14/15/16/17. Trigger sensitivity channel A and B



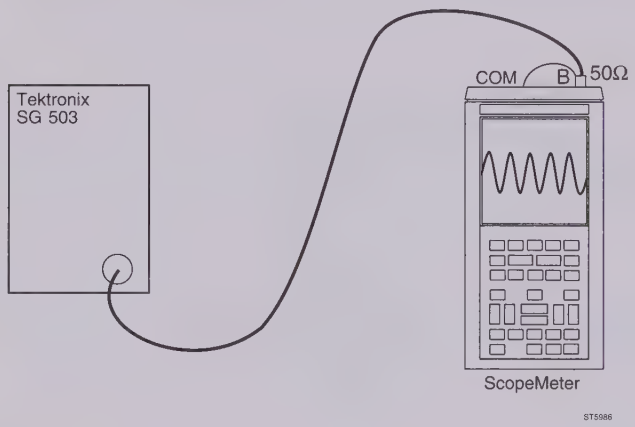
The trigger sensitivity depends on the frequency of the trigger signal. This test checks the trigger sensitivity and the +SLOPE/-SLOPE function (triggering on negative slope) for both channels A and B. Channel B is tested first. The verified limits include the trigger sensitivity and the trigger voltage level error.

Test equipment:

Tektronix SG 503 Constant Amplitude Sine Wave Generator

Test setup:

Connect the banana jack COM to the BNC common



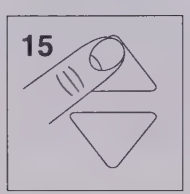
Procedure/requirements for channel B trigger sensitivity measurement:
For the FL92B and FL96B:

A Apply a 110 MHz sine wave, with an amplitude of approximately 1V peak to peak to the INPUT B BNC. Use a 50Ω termination.
B Adjust the amplitude of the input signal to exactly 2.9 divisions on the display.
C Verify that the signal is well triggered.
D Apply a 60 MHz sine wave, with an amplitude of approximately 130 mV peak to peak to the INPUT B BNC. Use a 50Ω termination.
E Adjust the amplitude of the input signal to exactly 2.1 divisions on the display.
F Verify that the signal is well triggered.

For the FL99B and FL 105B:

A Apply a 150 MHz sine wave, with an amplitude of approximately 1V peak to peak to the INPUT B BNC. Use a 50Ω termination.
B Adjust the amplitude of the input signal to exactly 2.9 divisions on the display.
C Verify that the signal is well triggered.
D Apply a 100 MHz sine wave, with an amplitude of approximately 130 mV peak to peak to the INPUT B BNC. Use a 50Ω termination.
E Adjust the amplitude of the input signal to exactly 2.1 divisions on the display.
F Verify that the signal is well triggered.

For all models:



G Apply a 10 MHz sine wave, with an amplitude of approximately 0.3 V peak to peak to the INPUT B BNC. Use a 50Ω termination.

H Adjust the amplitude of the input signal to exactly 1.4 divisions on the display.

I Verify that the signal is well triggered on the falling edge. See figure 4.5.

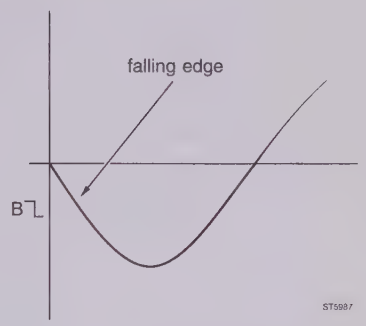
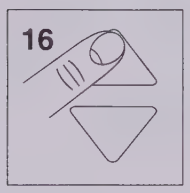
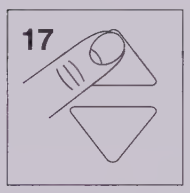


Figure 4.5 Signal triggered on the falling (negative) edge

Procedure/requirements for channel A trigger sensitivity measurement:

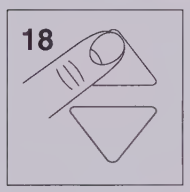


K Repeat steps G...I of step 15 for channel A.



L Repeat steps A...F of step 14 for channel A.

18. Timebase



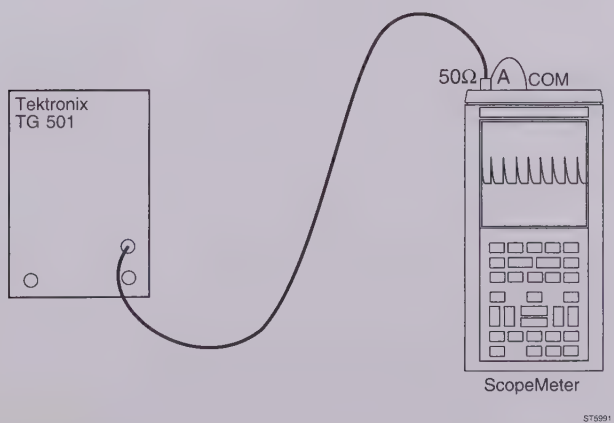
This test uses a marker pulse calibration signal to verify the deflection coefficient of the time base.

Test equipment:

Tektronix TG 501 Time Mark Generator

Test set-up:

Connect the banana jack COM to the BNC common



Procedure/requirements:

A Apply a 1 µs (1V peak-to-peak) time marker signal to the INPUT A BNC. Use a 50Ω termination.

B Verify that the distance between the 10th marker pulse and the 10th vertical grid line is the same as the distance between the 2nd marker pulse and the 2nd vertical grid line. (Tolerance ± 1 pixel = ± 0.04 divisions).

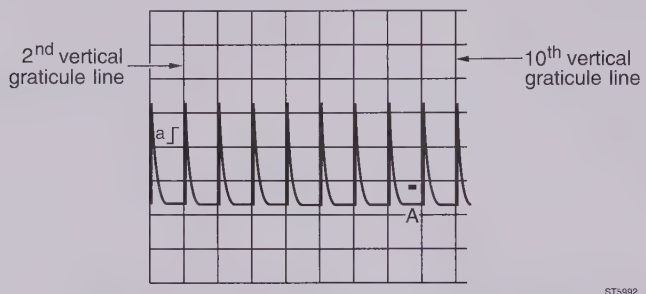


Figure 4.6 The distance between the 10th marker pulse and the 10th vertical grid line must be the same as the distance between the 2nd marker pulse and the 2nd vertical grid line

NOTE: This test can give the problem: "NOTRIG" on status line. It is caused by the new specification of the trigger gap. When this happens you should test the TIMEBASE outside the verification procedure.

Test setup:

Input A: 500 mV/div ac.
Probe: 1 : 1.
Timebase: 1 s/div .
Slope: positive.

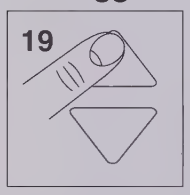
Procedure/requirements:

A Apply a 1 µs (1V peak-to-peak) time marker signal to the INPUT A BNC. Use a 50Ω termination.

B Adjust the trigger level to have stable triggering.

C Verify that the distance between the 10th marker pulse and the 10th vertical grid line is the same as the distance between the 2nd marker pulse and the 2nd vertical grid line. (Tolerance ± 1 pixel = ± 0.04 divisions)

19. Trigger sensitivity external channel

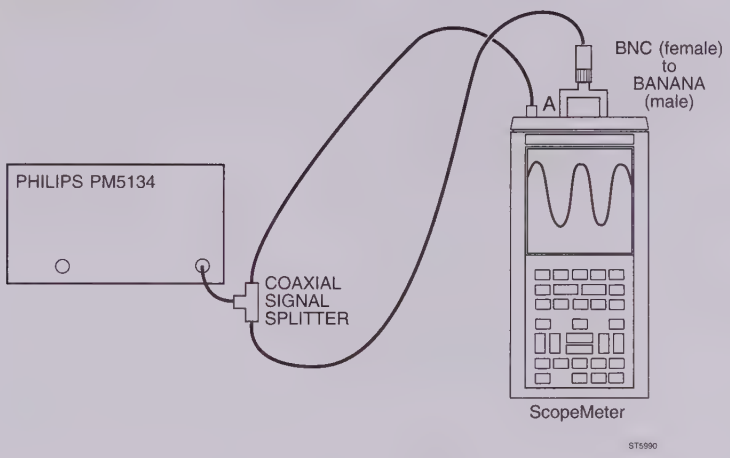


This test checks the trigger sensitivity, using the external banana connectors as the trigger input.

Test equipment:

Philips PM 5134 Function Generator

Test setup:



Procedure/requirements:

A Apply a 1 kHz sine wave signal, that has an amplitude of 1.8V peak-to-peak, superimposed on 1.4V DC to the INPUT A BNC and to the banana jack inputs. Use a coaxial signal splitter and a BNC-to-banana converter (see test setup).

B Verify that the signal is well triggered.

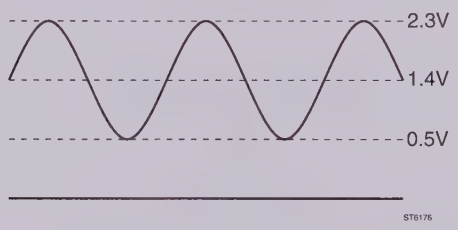


Figure 4.71.8V peak-to-peak sine wave superimposed on 1.4V DC

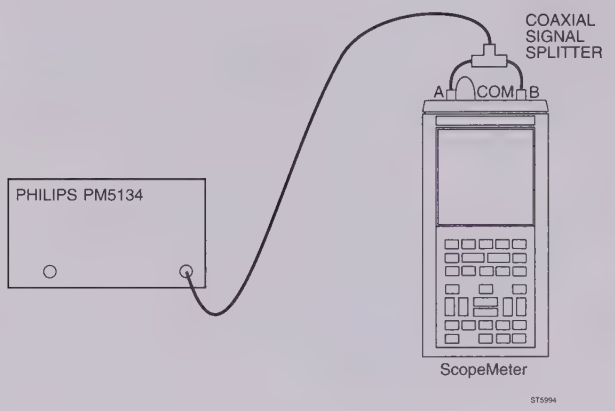
20. Horizontal deflection: x-deflection

This test checks the correct working of the X-Y (A versus B) mode.

Test equipment:

Philips PM 5134 Function Generator

Test set-up:



Procedure:

A Apply a 2 kHz sine wave signal of 800 mV peak-to-peak to the INPUT A BNC and INPUT B BNC. Adjust the input signal to a trace height of 8 divisions.

Requirements:

Verify that a figure with an angle of 45° is displayed, and that the gap is smaller than 10 pixels. See figure 4.8.

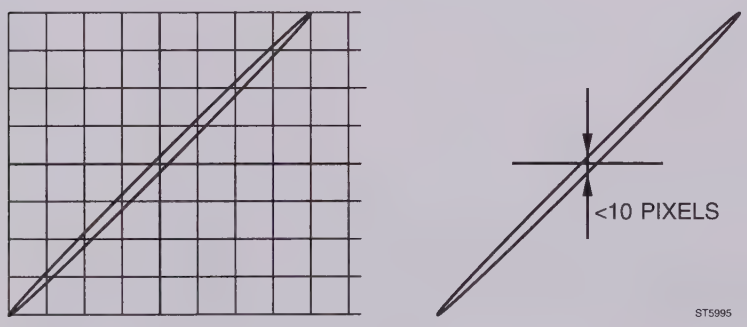


Figure 4.8 A versus B display

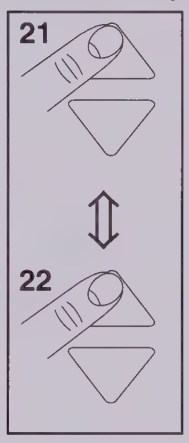
21/22. Base line instability

This test checks the maximum base line instability.

Test equipment:
none

Test setup:
no special setup required (open input).

Procedure/requirements:



A Turn off the signal sources connected to the ScopeMeter test tool input or minimize (zero) the signal amplitudes.

B Use the UP/DOWN keys to switch from front setting number 21 to number 22 and back to 21.

C Verify that the trace does not jump more than 0.2 divisions while switching between front settings 21 and 22.

While in the SERVICE menu, press the METER softkey to enter the **METER part of the Performance Verification Procedure.**

23/24/25/26/27, TV TRIGGER

These tests check the TV trigger modes of the ScopeMeter® test tools.

Test equipment:
Philips PM5418 TV generator.

General settings:

TV signal generator:

Amplitude:	1 V peak-peak (5 div.).
Line frequency:	15.6 kHz
Video system:	PAL (grey scale)
Connection:	Cable BNC to BNC PM9075
Terminator:	Feed through termination BNC to BNC from ITT-POMONO model 4119-75.

LINES MODE

A Apply the signal with the general settings and White Plane turned on.
B Use a 75Ω termination and 75Ω cable.
C Both line types (staircase and white area) should be visible, see Figure 4.9.

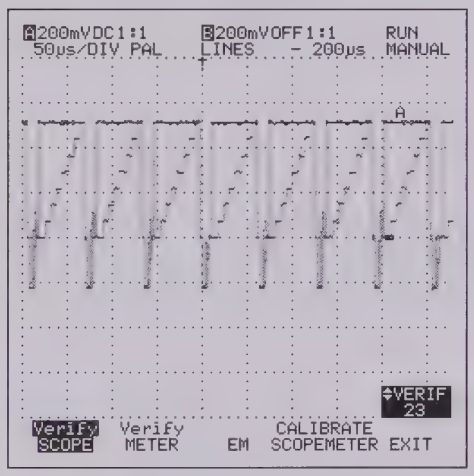
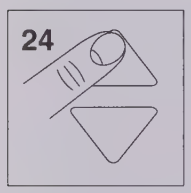


Figure 4.9

NEGATIVE VIDEO



A Apply the signal with the general settings with a reversed polarity. You can make reversed polarity by the use of two BNC to banana adapters, fore instance a PM9051 and a PM9053.
B Use a 75Ω termination and 75Ω cable.
C Line number 1 should be visible inverted, see Figure 4.10.

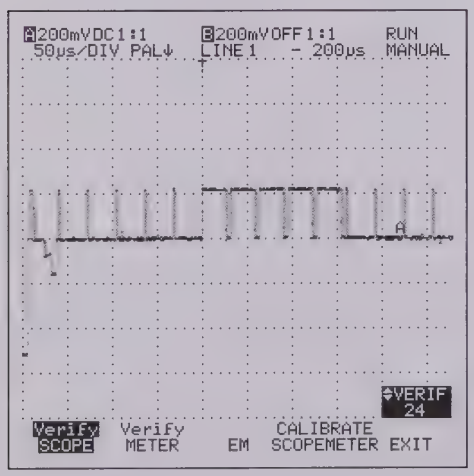
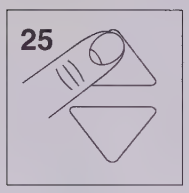


Figure 4.10

4- FIELD SEQUENCE 1



A Apply the signal with the general settings.
B Use a 75Ω termination and 75Ω cable.
C Check line number 313 is visible, see Figure 4.11.

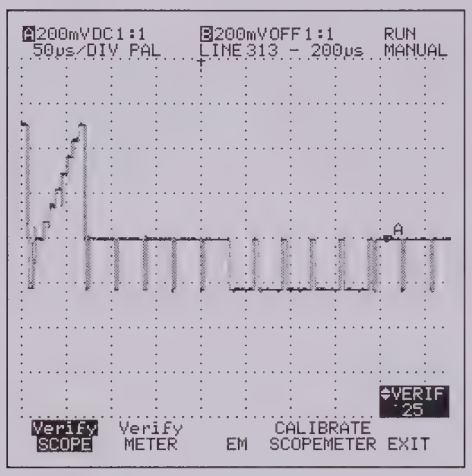


Figure 4.11

4- FIELD SEQUENCE 2

A Apply the signal with the general settings.
B Use a 75Ω termination and 75Ω cable.
C Check line number 625 is visible, see Figure 4.12.

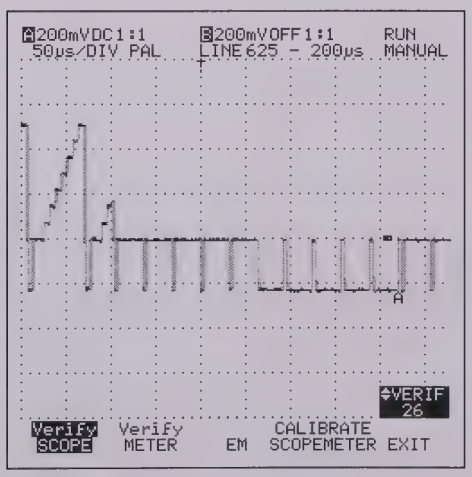
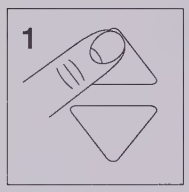


Figure 4.12

TV-OFF

A Apply the signal with the general settings.
B Use a 75Ω termination and 75W cable.
C Check the picture is not triggered (status line shows NOTRIG).

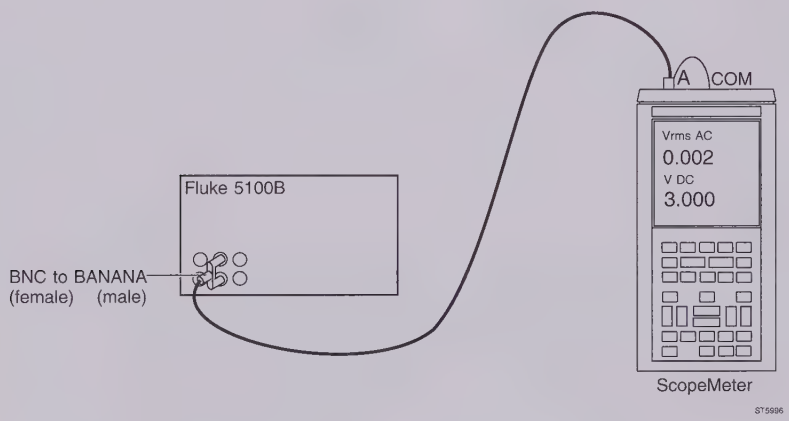
1. Voltage accuracy METER mode



The following section checks the voltage accuracy in METER mode. The ScopeMeter test tool uses the same input circuitry (hardware) for the SCOPE (channel A) and the METER modes (in these attenuator settings). When the voltage accuracy of the METER is checked, the deflection coefficients for SCOPE channel A are also tested.

Test equipment:
Fluke 5100B Calibrator

Test setup:
Connect the banana jack COM to the BNC common



Procedure:
A Apply 300 mV DC to the INPUT A BNC.
B Change the input signal according to table 4.3 and check that the reading meets the requirements.

NOTE: The ScopeMeter test tool is set to METER "AUTORANGE" (step 1) with a dual (AC and DC) readout. This implies that the range is set automatically according to the input signal.

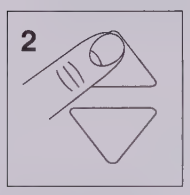
WARNING: After you have performed verification M1, deactivate the Fluke 5100B to remove the 100V. Always set the Fluke 5100B to 300 mV DC before touching the connection cables!

Requirements:

Table 4.3 Requirements for voltage accuracy test METER mode

Input signal	Requirements
300 mV DC	298.0...302.0V DC
300 mV RMS AC, 1 kHz	292.5...307.5V RMS AC
1V DC	0.990...1.010V DC
1V RMS AC, 1kHz	0.965...1.035V RMS AC
3V DC	2.980...3.020V DC
3V RMS AC, 1 kHz	2.925...3.075V RMS AC
30V DC	29.80...30.20V DC
30V RMS AC, 1 kHz	29.25...30.75V RMS AC
100V DC	099.0...101.0V DC
100V RMS AC, 1kHz	096.5...103.5V RMS AC

2. VOLTAGE accuracy EXT mV mode

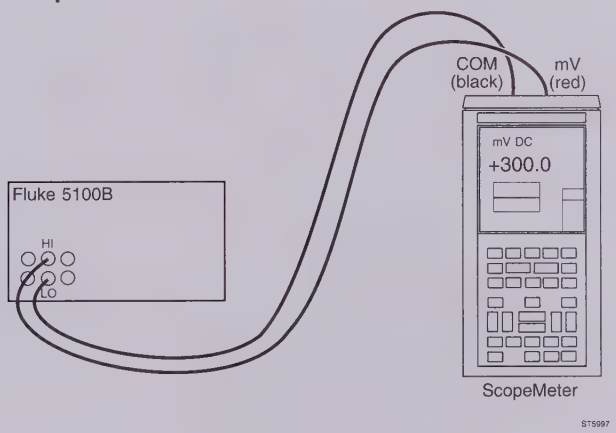


These tests check the accuracy of the EXT mV mode. The signal must be supplied to the banana jack inputs.

Test equipment:

Fluke 5100B Calibrator

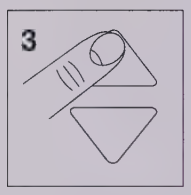
Test setup:



Procedure/requirements:

A Apply 300 mV DC to the banana jack inputs.
B Verify that the readout is between 298...302 mV DC.
C Apply 3V DC to the banana jack inputs.
D Verify that the readout is between 2.980...3.020V DC.
E Apply 250 mV RMS AC, 60 Hz to the banana jack inputs.
F Verify that the reading is between 243.5...256.5 mV AC.
G Apply 2V RMS AC, 60 Hz to the banana jack inputs.
H Verify that the reading is between 1.945...2.055V AC.

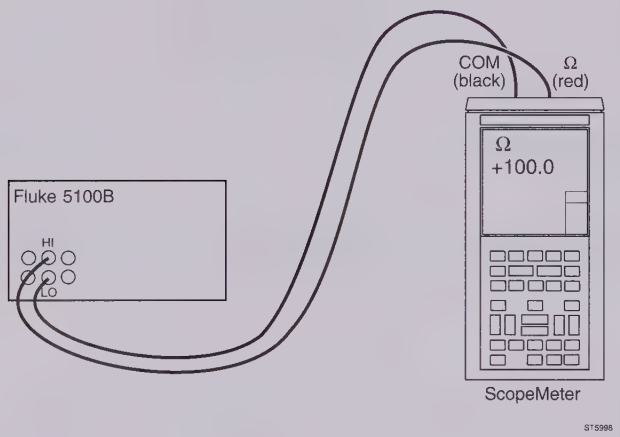
3. Resistance accuracy OHM mode



These tests check the accuracy of the OHM mode. The signal has to be supplied to the banana jack inputs.

Test equipment:
Fluke 5100B Calibrator

Test setup:



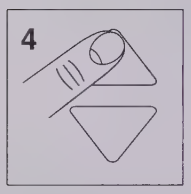
Procedure/requirements:
A Set the output of the Fluke 5100B to the values in table 4.4.
B Verify that the readings meet the requirements of listed in table 4.4.

Table 4.4 Requirements for Ohms accuracy test

Input signal	Requirements
0.0Ω (short)	000.0Ω...000.5Ω
100.0Ω	099.0Ω...101.0Ω
1.0 kΩ	0.990 kΩ...1.010 kΩ
10 kΩ	~~09.90~~ 09.90 kΩ...10.10 kΩ
100 kΩ	099.0 kΩ...101.0 kΩ
1 MΩ	0.990 MΩ...1.010 MΩ
10 MΩ	09.90 MΩ...10.10 MΩ

SDS 1-5-00

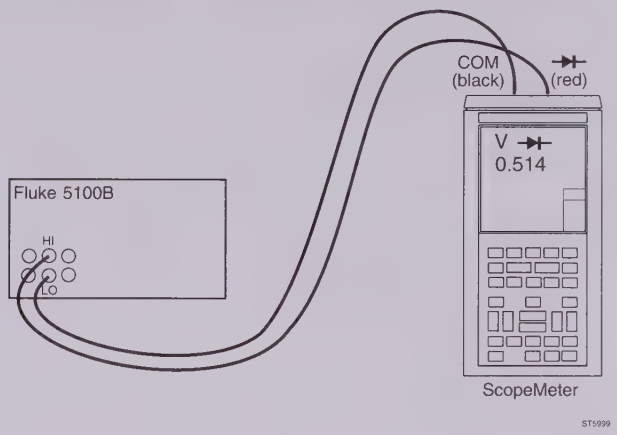
4. Diode test mode accuracy



This test checks the accuracy of the Diode test mode.

Test equipment:
Fluke 5100B Calibrator

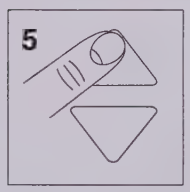
Test setup:



Procedure/requirements:

A Set the Fluke 5100B to 1V DC.
B Check that the readout is between 0.990...1.010 DC.

5. Signal display and frequency measurement



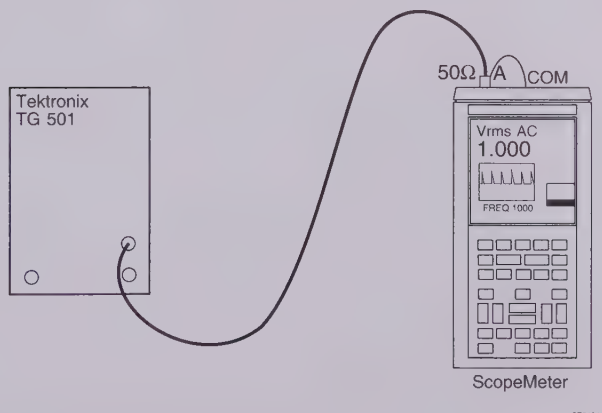
This test checks the waveform display and the frequency measurement function in METER MODE.

Test equipment:

Tektronix TG 501 Time Mark Generator

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements:

A Apply a 1 ms (1V peak-to-peak) time marker signal to the INPUT A BNC. Use a 50Ω termination.
B Check that a stable (triggered) signal is displayed.
C Check that the frequency displayed is between 993...1007 Hz.

4.3 ADDITIONAL PERFORMANCE VERIFICATION PROCEDURE

This paragraph describes the Additional Performance Verification Procedure.
This procedure can be used to do some extra performance tests, depending on the ScopeMeter test tool model. Follow the instructions described with each step.

The recommended test equipment required for this Additional Performance Verification Procedure is listed in table 4.4.

Table 4.4 Recommended test equipment for Additional Performance Verification Procedure

Instrument Type	Recommended Model
Function Generator	Philips PM 5134
Multimeter	Philips PM 2525
Power Supply	Philips PE 1537
Time Mark Generator	Tektronix TG 501
Constant Amplitude Sine wave Generator	Tektronix SG 503
Square wave Calibration Generator	Tektronix PG 506

- Cables and terminators for the generators (all BNC type)
- Two standard banana test leads (delivered with the ScopeMeter test tool)
- BNC (female)-to-banana (male) (delivered with the ScopeMeter test tool)
- 5 mm Power Jack connector plug with attached cable (e.g.: 4822 321 20125)

NOTE: During the following Performance Verification Procedure, you must connect the ScopeMeter test tool inputs to the signal generator outputs. This connection must be made by coaxial cables (INPUT A or B BNC) or two standard banana test leads (banana jack inputs). The Additional Performance Verification Procedure does not use the oscilloscope probes delivered with the instrument. The calibration of the probes is described in the Operating Manual.

RESET

Before each additional verification procedure step the ScopeMeter test tool must be reset in the following way:

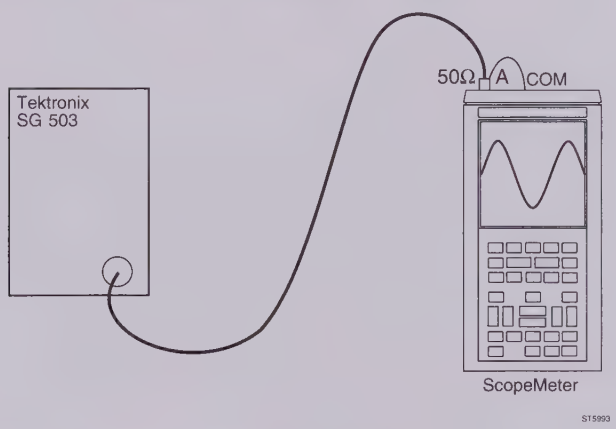
1 Turn the test tool off.
2 Press and hold the F1 key.
3 Pres and release the ON-OFF key.
The test tool turns on, and you should hear a single beep.
input: A PROBE 1:1 appears on the display.
4 Release the F1 key.

1. Autoset

This test checks the correct operation of the AUTO SET function.

Test equipment:
Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:
Connect the banana jack COM to the BNC common



Settings/procedure/requirements:
A Reset the ScopeMeter test tool.
B Press the F1 key to select SCOPE mode.
C Apply a 50 MHz sine wave signal of 100 mV peak-to-peak to the INPUT A BNC. Use a 50Ω termination.
D Press the AUTO SET key. Check that the display is stable and well triggered. Minimal 2 and maximal 20 signal periods must be displayed, over 8 divisions. The signal amplitude must be approximately 5 divisions. The NOTRIG indication on the display must not flash.
E Repeat settings/procedure for the INPUT B BNC.

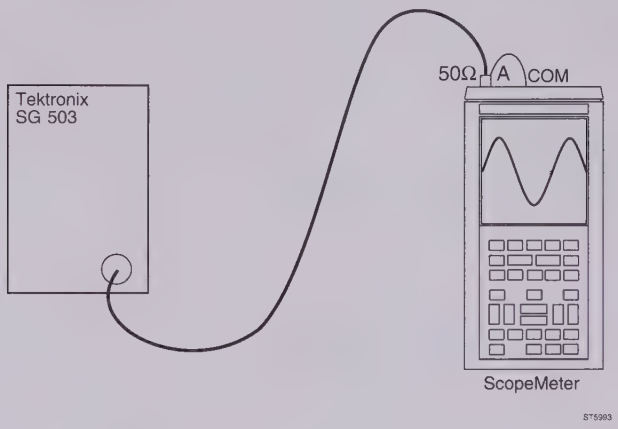
2. Vertical dynamic range and position range (move control)

This test checks the vertical dynamic range, together with the position range (move control). A certain overdrive of the ScopeMeter test tool must be allowed.

Test equipment:
Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:

Connect the banana jack COM to the BNC common



Settings/procedure/requirements for input A:

A Reset the ScopeMeter test tool.

Vertical dynamic range check:

B Press the F1 key to select SCOPE mode.

C Apply a 50 kHz sine wave signal of 950 mV peak-to-peak to the INPUT A BNC. Use a 50Ω termination.

D Press the AUTO SET key. Set INPUT A to 100 mV/div. and set the timebase speed to 10µs/div.

E Use the vertical MOVE key to shift the bottom of the sine wave vertically over the screen in the lower division. Shift the top of the sine wave in the upper division. Verify that the top and bottom of the sine wave signal of 9.5 divisions can be displayed distortion free.

F Apply a 100 MHz sine wave signal of approximately 500 mV peak- to-peak (4 divisions on the screen) to the INPUT A BNC. Use a 50Ω termination.

G Set the timebase speed to 5 ns/div.

H Now a sine wave with an amplitude of 4 divisions must be displayed distortion free.

Move control check:

A Adjust the signal amplitude to 8 divisions on the screen.

B Check that the trace can be moved over 4 divisions up (+ 4 div.) and over 4 divisions down (- 4 div.).

Settings/procedure/requirements for input B:

Repeat the total procedure for input B.

3. Trigger level control range

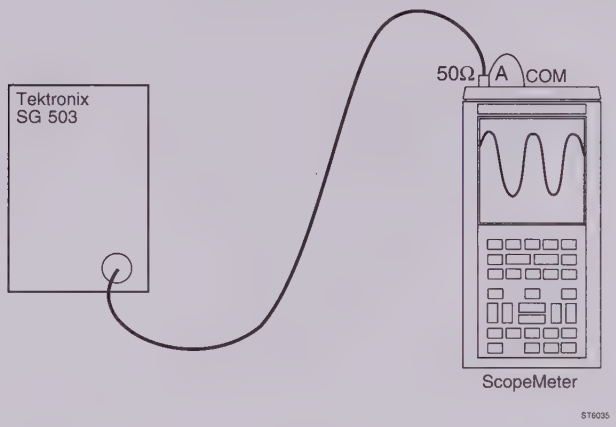
This test checks the trigger level control range.

Test equipment:

Tektronix SG 503 Constant Amplitude Sine wave Generator

Test setup:

Connect the banana jack COM to the BNC common



Settings/procedure/requirements

A Reset the test tool.

B Press the F1 key to select SCOPE mode.

C Apply a 500 kHz sine wave with an amplitude of 950 mV peak-to-peak to the INPUT A BNC. Use a 50Ω termination.

D Press the AUTOSET key and verify that the signal is well triggered.

E Set the INPUT attenuation to 100 mV/div., and the time base to 500 ns/div.

F Press the TRIGGER key and then the F4 key (ADJUST LEVEL). Adjust the trigger level with the ▲ and the ▼ keys.
Verify that the signal is well triggered over a trigger level range of 8 divisions (4 divisions up, and 4 divisions down).
The trigger level value is displayed. The trigger level marker (Al) will shift while adjusting the trigger level. See figure 4.9

G Repeat the same procedure for INPUT B.

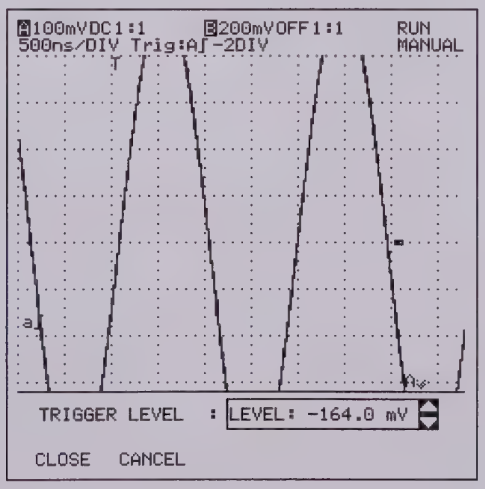


Figure 4.13 Trigger level control

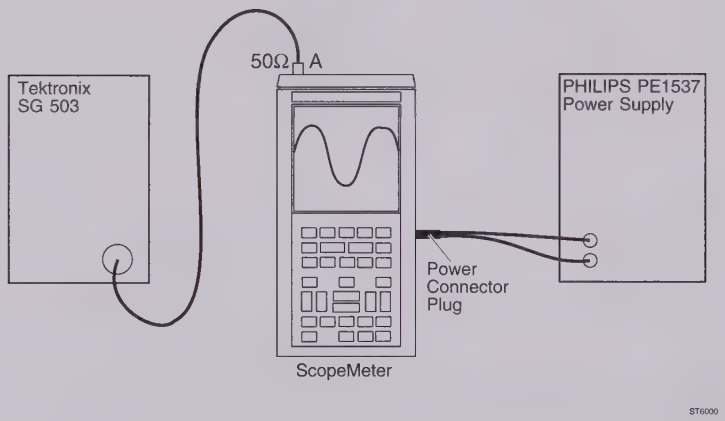
4. Power supply voltage range

This test checks the correct operation of the ScopeMeter test tool within the boundaries of the DC supply voltage.

Test equipment:

Philips PE 1537 Power Supply 0-40V/0-1A
Tektronix SG 503 Constant Amplitude Sine Wave Generator
5 mm Power Jack connector plug with attached cable (for example order 4822 321 20125)

Test set-up:



Settings/procedure:

A Insert the power plug into the power adapter contact on the right side of the ScopeMeter test tool.
B Turn on the PE1537 power supply and set the voltage to a value between 8 and 20V DC.
C Apply a 50 kHz sine wave with an amplitude of 100 mV peak-to- peak to the INPUT A BNC. Use a 50Ω termination.
D Turn on the ScopeMeter test tool. At power on, a beep tone must be audible.
E Press the SCOPE/METER key to select SCOPE mode.
F Press AUTO SET and verify that a well triggered signal with an amplitude of approximately 5 divisions is displayed over the whole supply voltage range.

Requirements:

A The ScopeMeter test tool must start at any DC voltage between 8 and 20V, applied at its power adapter contact.
B The test tool must remain operative over the indicated voltage range.
C The amplitude of the trace displayed must be approximately 5 divisions, independent of the supply voltage.

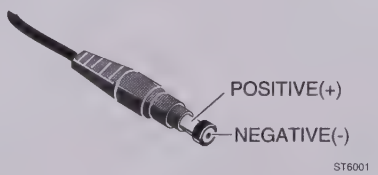


Figure 4.14 Power Jack connector

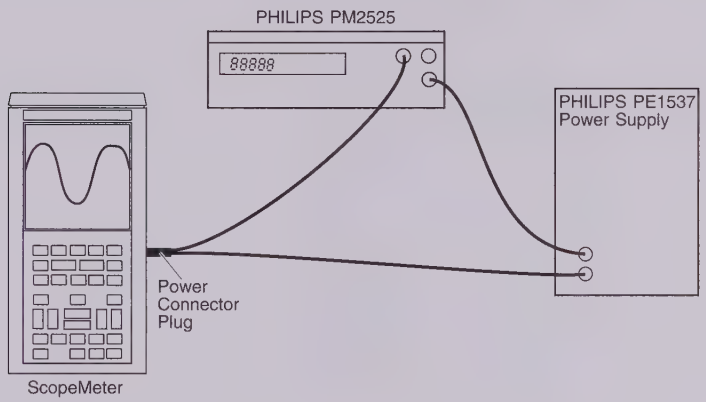
5. Supply current

This test checks the total supply current (supply current and the built-in battery charger current).

Test equipment:

Philips PE 1537 Power Supply 0-40V/0-1A
Digital Multimeter (Philips PM 2525 or equivalent)
5 mm Power Jack connector plug with attached cable (for example order 4822 321 20125).

Test set-up:



Settings/procedure/requirements:

NOTE: A PM 9086 battery pack (included in the shipment) has to be installed for this test. Only NiCad batteries can be charged by the ScopeMeter test tool!

A Set the PE1537 power supply to 15V DC.
B Check that the charging current is 170 mA (typical reading on multimeter).
C Turn on the ScopeMeter test tool.
D Check that the total supply current is 400 mA (typical reading on multimeter).

6. Battery backup functional test

This test verifies that the ScopeMeter test tool settings will be kept in memory if power is switched off while the batteries are removed.

Test equipment:

none

Test setup:

no specific test setup required

Settings/procedure:

A Remove the battery pack (see section 6.2.1) and power the test tool via the PM8907 power adapter.
B Turn on the ScopeMeter test tool and press the F1 (SCOPE) key to get into scope mode.
C Press the AUTO SET key and set input A to 500 mV/div. Set the timebase to 1 ms/div.
D Turn off the ScopeMeter test tool and keep it switched off for one hour to enable all capacitors to discharge.
E Turn on the ScopeMeter test tool again, and verify that the settings for the timebase and attenuator have not changed.

Requirements:

ScopeMeter test tool settings at power off must be recalled each time power is turned on.

7. Cursor measurements: time accuracy

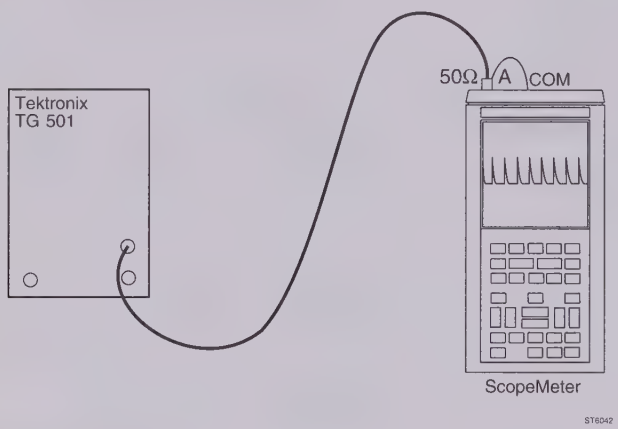
This test checks the accuracy of the cursors while measuring time.

Test equipment:

Tektronix TG 501 Time Mark Generator

Test setup:

Connect the banana jack COM to the BNC common



Setting/procedure:

A Reset the test tool.
B Press the F1 key to select SCOPE mode.
C Apply a 1 ms time marker signal to the input A BNC and then press the AUTOSET key.
D Set the time base to 1 ms/div.
E Press the HOLD-RUN key to freeze the display.
F Select dt cursor measurements by pressing the following keys:

SUBMENU >> **F1** (more scope) >> **F4** (next page) >> ▲ or ▼ to highlight **CURSOR READINGS** >> **F5** (select item) to select **CURSOR READINGS** >> ▲ or ▼ to highlight **ADD MAIN READING** >> **F5** to select the cursor functions menu >> ▲ or ▼ to highlight **dt** >> **F5** to select dt >> **F1** (close) to leave the menu.

G Position the cursor lines with the LEFT CURSOR and the RIGHT CURSOR key, so that the vertical cursor lines cover a distance of six time marker intervals. See figure 4.11.

Requirements:

The measured time distance between the cursors (dt) must be **6.00** ms.

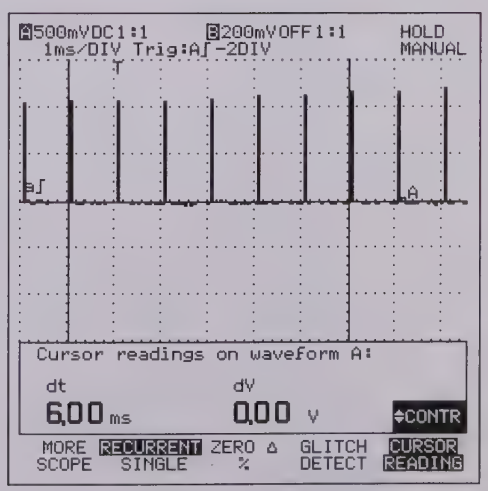


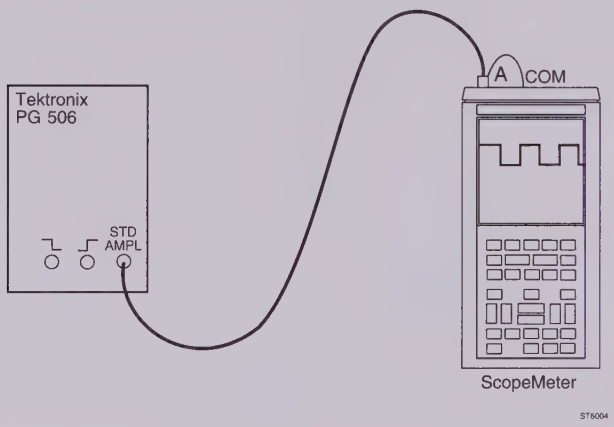
Figure 4.15 Cursor lines on marker pulses

8. Cursor measurements: voltage accuracy

This test checks the accuracy of the cursors while measuring voltage.

Test equipment:
Tektronix PG 506 Square Wave Calibration Generator

Test setup:
Connect the banana jack COM to the BNC common



Setting/procedure:

A Reset the test tool.
B Press the F1 key to select SCOPE mode.
C Apply a 1 kHz square wave of 1V peak-to-peak to the input A BNC and then press the AUTOSET key.
D Press the INPUT A key and then press the F3 key two times to select AC input coupling. Set input A to 0.2 V/div. The displayed signal amplitude is 5 divisions.
E Press the HOLD-RUN key to freeze the display.
F Select dV cursor measurements by pressing the SUB MENU key and then the F5 key. If cursor measurements are already on, the F5 key will switch off cursor measurements. Press F5 again to switch on.
G Position the left cursor lines with the LEFT CURSOR key to the horizontal middle of the top of the waveform.
H Position the right cursor lines with the RIGHT CURSOR key to the horizontal middle of the bottom of the waveform.

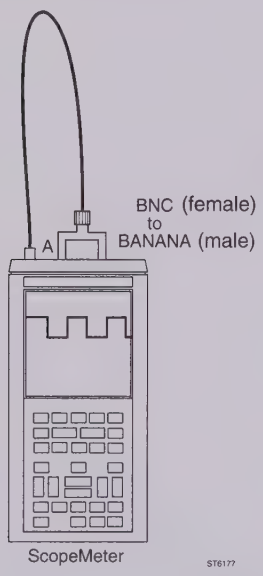
Requirements:
The measured voltage dV must be **972 mV** ... **1.03V**.

9. Generator

This test checks the built-in generator.

Test equipment:
none

Test setup:



Setting/procedure/requirements:

Square wave

A Reset the test tool.
B Press the F1 key to select SCOPE mode.
C Press the SPECIAL FUNCT key. Now press the F2 key (generate menu) to reveal the generator menu.
D Press the F5 key (select item) to turn the generator on if it is off.
E Press the ▼ key to highlight GENERATOR WAVEFORM, and press the F5 key to open the generator function menu.
Highlight SQUARE 1.95 kHz (or SINE if you continued at J) with the ▲ or ▼ key and press the F5 key to select this item. Pres the F1 key (close) to leave the generator menu.
F Press the AUTOSET key.
G Select frequency cursor measurements by pressing the following keys (if you continued from J you can skip this step, and go to H):

SUBMENU >> **F1** (more scope) >> **F4** (next page) >> ▲ or ▼ to highlight **CURSOR READINGS** >> **F5** (select item) to select **CURSOR READINGS** >> ▲ or ▼ to highlight **ADD MAIN READING** >> **F5** to select the cursor functions menu >> ▲ or ▼ to highlight **FREQUENCY** >> **F5** to select **FREQUENCY** >> **F1** (close) to leave the menu.

H Position the left vertical cursor line with the LEFT CURSOR key to the left screen margin. Position the right vertical cursor line with the RIGHT CURSOR key to the right screen margin.

I The display will look like figure 4.12. The generator must produce a square wave signal with an amplitude of 5V and a frequency of 1.95 kHz (typical values).

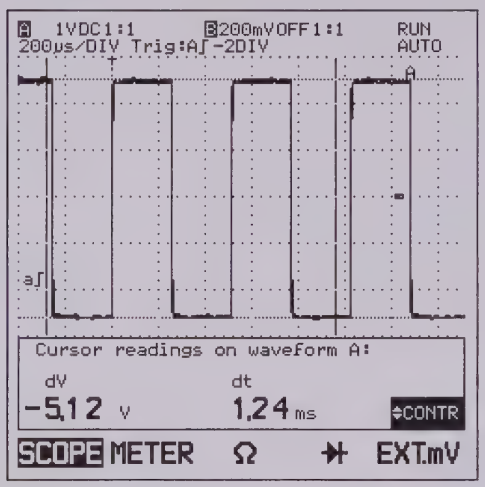


Figure 4.16 Generator square wave signal.

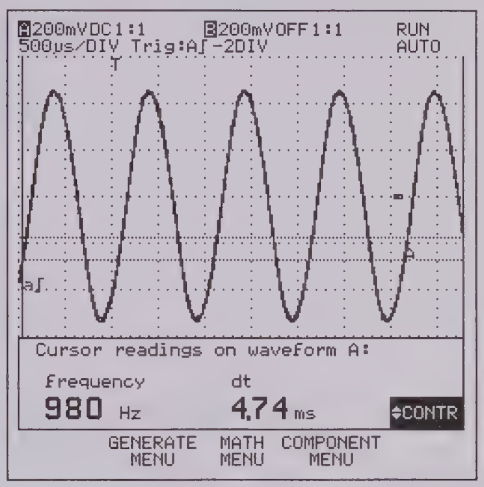


Figure 4.17 Generator sine wave signal.

Sine wave

J Start at C again and select SINE WAVE at E.

K The display will look like figure 4.13. The generator must produce a sine wave signal with an amplitude of 1V and a frequency of 976 Hz (typical values).

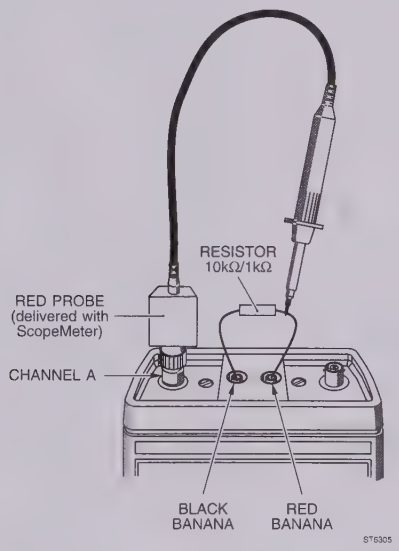
10. Component test function

This test checks the component test function (slow ramp voltage and slow ramp current).

Test equipment:

Red scope probe (delivered with the ScopeMeter test tool)

Test setup:



Settings/procedure/requirements

A Turn the test tool off. Press and hold the F5 key, and turn the test tool on. Release the F5 key after you hear two beeps. The 10:1 probe is selected now.

Voltage sweep

B Connect a 10 kΩ resistor to the banana input sockets. Connect the red 10:1 probe as indicated in the test setup figure above.

C Press the SPECIAL FUNCT key, and then press the F4 key to open the Component Test menu. Press F5 to turn the component test on.

D Press the ▼ key to highlight the TEST Waveform SOURCE. Press the F5 key to open the voltage/current window. Press the ▲ or ▼ key to highlight voltage sweep, and press the F5 key to select voltage sweep. Press the F1 key to close the menu.

E Adjust the INPUT A attenuator with the mV-RANGE-V key to 0.5V/div.
The display must show a 45° line. See figure 4.14

Current sweep

F Connect a 1 kΩ resistor to the banana input sockets. Connect the red 10:1 probe as indicated in the test setup figure above.

G Press the SPECIAL FUNCT key, and then press the F4 key to open the Component Test menu. Press F5 to turn the component test on.

H Press the ▼ key to highlight the TEST Waveform SOURCE. Press the F5 key to open the voltage/current window. Press the ▲ or ▼ key to highlight current sweep, and press the F5 key to select current sweep. Press the F1 key to close the menu.

I Adjust the INPUT A attenuator with the mV-RANGE-V key to 20 mV/div.
The display must show a line as indicated in figure 4.15.

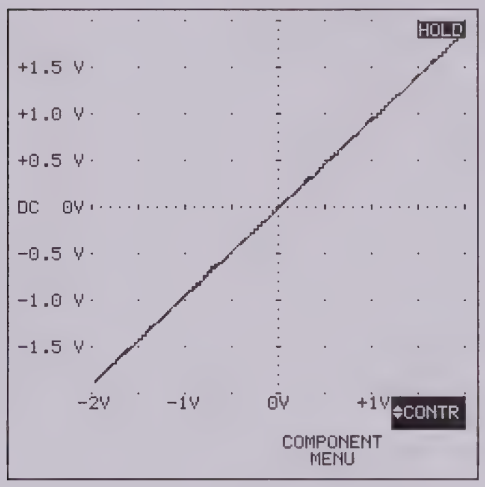


Figure 4.18 Component test voltage sweep

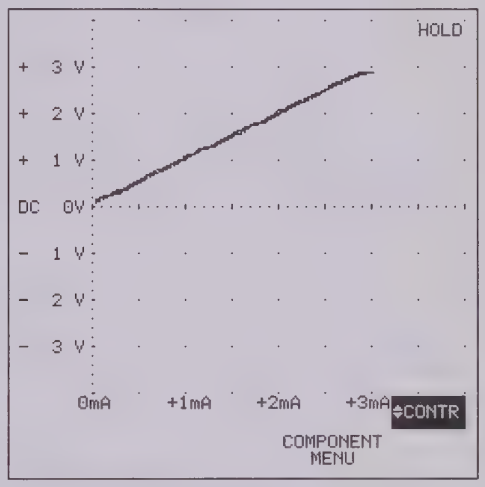


Figure 4.19 Component test current sweep

4 PERFORMANCE VERIFICATION PROCEDURE

4.1 GENERAL INFORMATION

The ScopeMeter test tool should be calibrated and in operating condition when you receive it.

The following performance tests are provided to ensure that the test tool is in a proper operating condition. If the instrument fails any of the performance tests, calibration adjustments (see chapter 5) and/or repair (see chapter 7) is necessary.

The Performance Verification Procedure described here consists of two parts:
- Standard Performance Verification Procedure (separate SCOPE- and METER-section)
- Additional Performance Verification Procedure

In the Standard Performance Verification Procedure of Firmware version V8.50 or newer, you can select the TV video system you want to use. After a total reset the NTSC system is selected. To select another system:
- Switch the ScopeMeter test tool on.
- Press SCOPE to select the scope mode.
- Press TRIGGER
- Press F1, MORE TRIGGER.
- Press F4, NEXT PAGE twice to select page 3
- Press the DOWN ▼ key to highlight TV SYSTEM.
- Press F5, SELECT ITEM.
- Press the UP ▲ or down ▼ key to highlight the VIDEO system.
- Press F5 to select the VIDEO SYSTEM.
- Press F1 to close the selection.

You can continue with the Standard Performance Verification Procedure or MetCal procedure.

The Standard Performance Verification Procedure uses built-in front panel settings or front settings, that can be accessed via the SERVICE MENU. To enter the SERVICE MENU, press the backlight key, then press AUTOSET, and then release the backlight key. This menu allows you to choose between SCOPE and METER performance testing ("Verify").

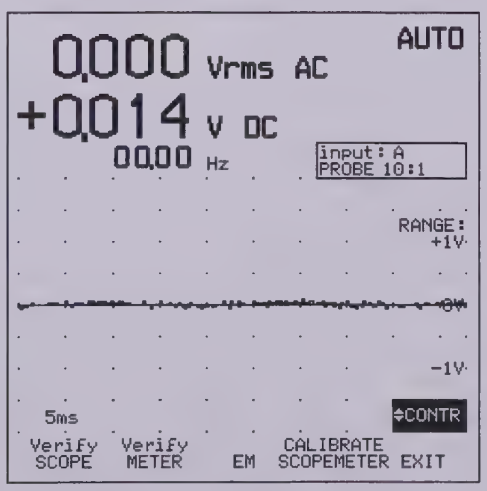


Figure 4.1 Service menu (entered from METER mode)

When the ScopeMeter test tool is in SERVICE mode, only the function keys (F1 .. F5), the UP/DOWN keys (▲ ▼) and the ON/OFF key (ON OFF) can be used.
It is possible to move forward or backward through the frontsettings, that apply to the separate performance test steps. This can be done using the UP/DOWN keys. You can leave the Performance Verification Procedure any time by pressing function key F5. The Performance Verification Procedure steps are explained in the following sections.

The **Additional Performance Verification Procedure** can be used to do some extra checks, depending on the ScopeMeter test tool version. In these tests the ScopeMeter test tool must be set up manually.

NOTE: This Performance Verification Procedure is a quick way to check most of the instrument's specifications. Because of the highly integrated design of the ScopeMeter test tool, it is not always necessary to check all features separately. The procedure described here often combines many test steps in one procedure step, thereby minimizing total test time.

The Performance Verification Procedure is based on the specifications, listed in chapter 2 of this Service Manual. The values (requirements) given here are valid for ambient temperatures between 18°C and 28°C.

4.2 STANDARD PERFORMANCE VERIFICATION PROCEDURE

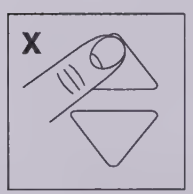
This section explains the required Performance Verification Procedure setup, with the actions that have to be done for each step. Follow the instructions described with each step.
The recommended test equipment, required for this Standard Performance Verification Procedure, is listed in table 4.1.

Table 4.1 Recommended test equipment Standard Performance Verification Procedure

Instrument Type	Recommended Model
Multi-Product Calibrator with SCOPE option	Fluke 5500A
TV Signal Generator	PM5418

- Cables and terminators for the Multi-Product Calibrator all BNC type).
- Two standard banana test leads (delivered with the ScopeMeter test tool)
- 2 x BNC (female)-to-banana (male) adapter PM9081.
- 2 x BNC (male)-to-banana (female) adapter PM9051.
- 2 x T-piece PM9067.
- The red and grey probes, delivered **with** the ScopeMeter test tool.

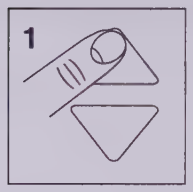
NOTE: During the following Performance Verification Procedure, the ScopeMeter test tool inputs are connected to the signal generator outputs by means of coaxial cables (INPUT A or B BNC) or two standard banana test leads (banana jack inputs). The oscilloscope probes delivered with the instrument are not used during the Standard Performance Verification Procedure. The calibration of the probes is described in the Users Manual.



In the following text, this figure is used to indicate that one of the UP key (▲) or the DOWN key (▲) must be pressed, to display the indicated step number "x".

1/2. LCD test

While in the SERVICE menu, press the SCOPE function key to enter the SCOPE section of the Performance Verification Procedure.



Now a (dark) test pattern is displayed. This pattern consists of a circle placed in a square, and three diagonal lines (see figure 4.2).

Observe the test pattern closely. The lines may not be interrupted; the pattern must be continuous. In this test sets the display to a high contrast, resulting in a dark display. If there are defects in the pixel columns of the Liquid Crystal Display, they must be clearly visible now as intermissions in the pattern.

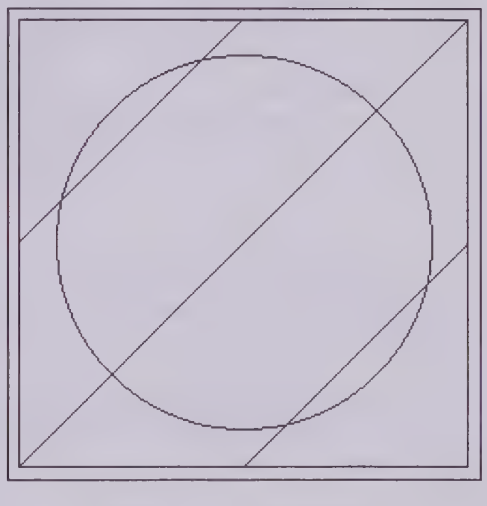
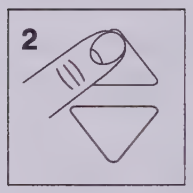
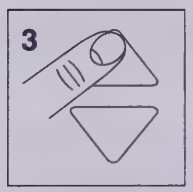


Figure 4.2 Test pattern



Press the UP key again to go to step 2. Now the display shows the same pattern, but with a low contrast (bright display). This will help you to locate any failures in the pixel rows of the LCD.

3. Ground level check



Press the UP key to go to step 3. The purpose of this step is to check the ground level position adjustments (0V) for both traces. The display shows the text " Verif 3", to show that this is the third SCOPE Performance Verification step (see figure 4.3).

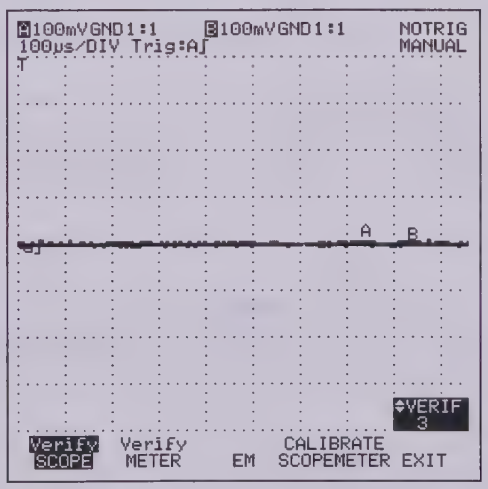
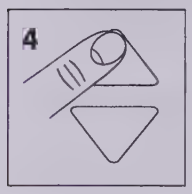


Figure 4.3 Reference set-up

Requirements:

Verify that the traces of both channels A and B are situated on the vertical middle of the screen.

4. Vertical deflection coefficients channel A



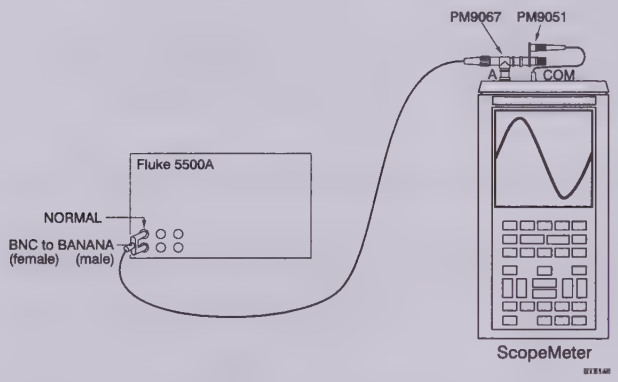
These tests check the vertical deflection coefficients for channel A in the 100 mV/div AC range.

Test equipment:

Fluke 5500A Multi-Product Calibrator, output NORMAL, WAVE sine.

Test setup:

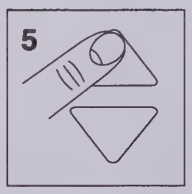
Connect the banana jack COM to the BNC common



Procedure/requirements for AC test:

A Apply a 1 kHz sine wave signal with an amplitude of 600 mV AC peak-to-peak to the INPUT A BNC.
(Set the Fluke 5500A to 212.13 mV RMS, 1 kHz sine wave).
Verify that the amplitude of the sine wave signal displayed is 5.84...6.16 divisions.

5/6/7. Vertical deflection coefficients channel B



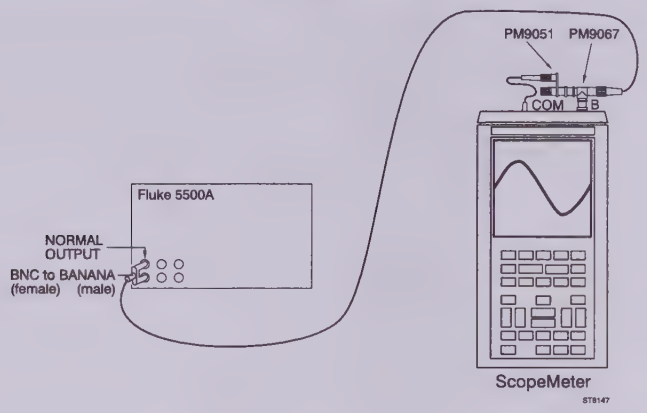
These tests check the vertical deflection coefficients for channel B in the AC ranges.

Test equipment:

Fluke 5500A Multi-Product Calibrator, output NORMAL (SCOPE off).

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements for channel B AC tests:

Apply the input voltage and the setting of channel B according to table 4.2 and check that the amplitude of the signal agrees with the value listed. Use the UP/DOWN keys to select each step number.

NOTE: The AC voltages listed in this are peak-to-peak voltages (sine wave). The values listed between brackets () are the RMS values that have to be chosen on the Fluke 5500A calibrator.

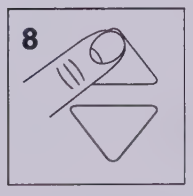
Requirements:

Table 4.2 Requirements vertical deflection coefficients for channel B

Input voltage	Step number on display	Requirements
600 mV AC pp (212.13mV RMS), 1 kHz	"5"	5.84...6.18 div.
6V AC pp (2.1213V RMS), 1 kHz	"6"	5.84...6.18 div.
60V AC (21.213 V RMS), 1 kHz	"7"	5.84...6.18 div.

The ScopeMeter test tool uses the same input circuitry (hardware) for the SCOPE and the METER modes (in the above attenuator settings). When the voltage accuracy is checked (see the description "METER Performance Verification Procedure" step 1), the deflection coefficients for SCOPE channel A are also tested.

8/9. Rise time



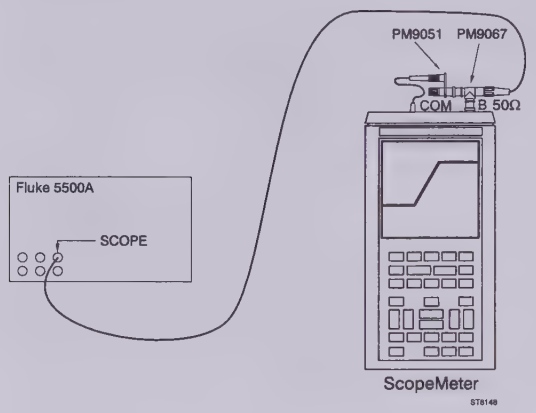
The rise time of the test tool is checked by means of a fast rise time pulse. First channel B is measured.

Test equipment:

Fluke 5500A Multi-Product Calibrator, SCOPE mode, mode EDGE.

Test setup channel B rise time measurement:

Connect the banana jack COM to the BNC common



Procedure for channel B rise time measurement:

A Apply a fast rise time pulse, repetition frequency 1 MHz, amplitude 0.500V to the INPUT B BNC. Use a 50Ω termination.

B Adjust the pulse amplitude to exactly 5 divisions. See figure 4.4.

Requirements:

C Check the rise time, measured between 10% and 90% of the pulse amplitude. See figure 4.4.

The rise time t_r (measured) must be 5.8 ns for the Fluke 92B, 96B or 3.5 ns for the Fluke 99B, 105B.

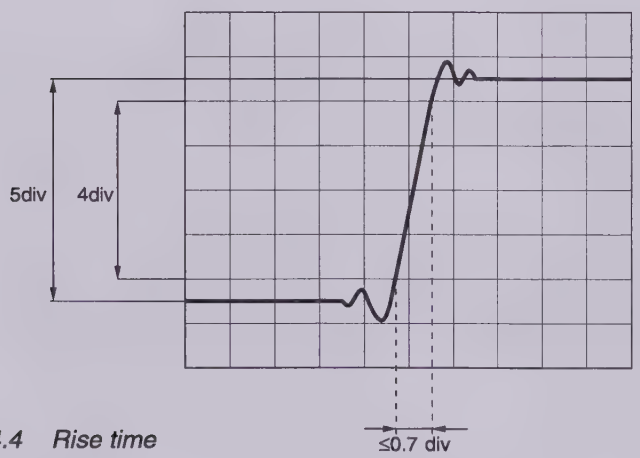
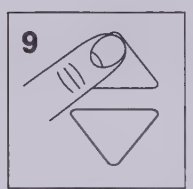


Figure 4.4 Rise time



Test setup channel A rise time measurement:

Refer to the test set-up for channel B measurement. Connect the pulse generator to the INPUT A BNC.

Procedure for channel A rise time measurement:

Refer to the settings/procedure for channel B measurement.

Requirements:

Refer to channel B requirements.

10/11/12/13. Frequency response

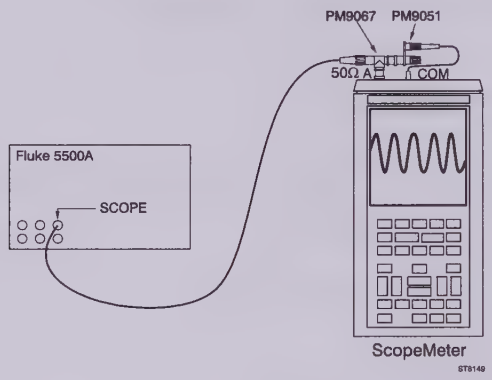
These tests check the upper transition point of the bandwidth for channels A and B.

Test equipment:

Fluke 5500A Multi-Product Calibrator, mode SCOPE, MODE levsine.

Test setup:

Connect the banana jack COM to the BNC common

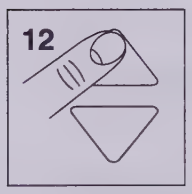


Procedure/requirements for channel A frequency response measurement:

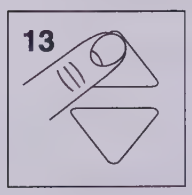
A Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to the INPUT A BNC. Use a 50Ω termination. Adjust the input signal to a trace height of exactly 6 divisions.

B Without changing the amplitude of the sine wave signal, switch over to step 11 using the UP key. Increase the frequency of the sine wave to 60 MHz for the Fluke 92B, 96B or 100 MHz for the Fluke 99B, 105B and verify that the vertical deflection is 4.2 divisions or more.

Procedure/requirements for channel B frequency response measurement:

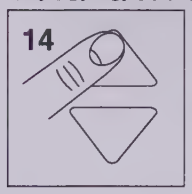


C Apply a 50 kHz sine wave with an amplitude of 120 mV peak-to- peak to the INPUT B BNC. Use a 50Ω termination.
Adjust the input signal to a trace height of exactly 6 divisions.



D Without changing the amplitude of the sine wave signal, switch over to step 13 using the UP key. Increase the frequency of the sine wave to 60 MHz for the Fluke 92B, 96B or 100 MHz for the Fluke 99B, 105B and check that the vertical deflection is 4.2 divisions or more.

14/15/16/17. Trigger sensitivity channel A and B



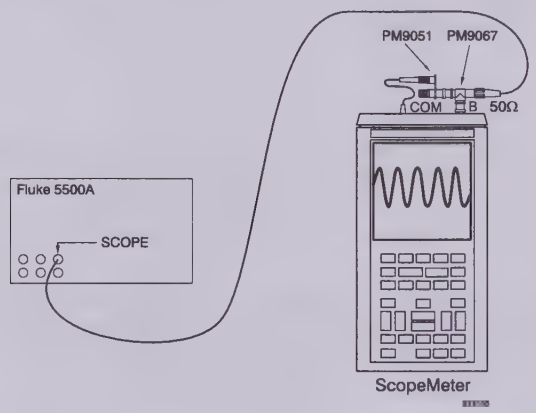
The trigger sensitivity depends on the frequency of the trigger signal. This test checks the trigger sensitivity and the +SLOPE/-SLOPE function (triggering on negative slope) for both channels A and B. Channel B is tested first. The verified limits include the trigger sensitivity and the trigger voltage level error.

Test equipment:

Fluke 5500A Multi-Product Calibrator, mode SCOPE, MODE levsine.

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements for channel B trigger sensitivity measurement:

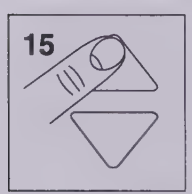
For the FL92B and FL96B:

A Apply a 110 MHz sine wave, with an amplitude of approximately 0.4V peak to peak to the INPUT B BNC. Use a 50Ω termination.
B Adjust the amplitude of the input signal to exactly 2.9 divisions on the display.
C Verify that the signal is well triggered.
D Apply a 60 MHz sine wave, with an amplitude of approximately 130 mV peak to peak to the INPUT B BNC. Use a 50Ω termination.
E Adjust the amplitude of the input signal to exactly 2.1 divisions on the display.
F Verify that the signal is well triggered.

For the FL99B and FL 105B:

A Apply a 150 MHz sine wave, with an amplitude of approximately 0.4V peak to peak to the INPUT B BNC. Use a 50Ω termination.
B Adjust the amplitude of the input signal to exactly 2.9 divisions on the display.
C Verify that the signal is well triggered.
D Apply a 100 MHz sine wave, with an amplitude of approximately 130 mV peak to peak to the INPUT B BNC. Use a 50Ω termination.
E Adjust the amplitude of the input signal to exactly 2.1 divisions on the display.
F Verify that the signal is well triggered.

For all models:



G Apply a 10 MHz sine wave, with an amplitude of approximately 0.3 V peak to peak to the INPUT B BNC. Use a 50Ω termination.

H Adjust the amplitude of the input signal to exactly 1.4 divisions on the display.

I Verify that the signal is well triggered on the falling edge. See figure 4.5.

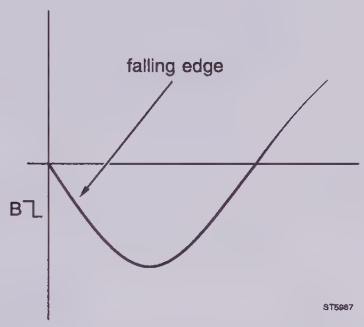
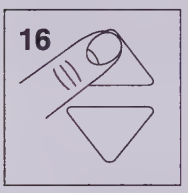
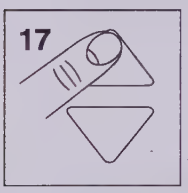


Figure 4.5 Signal triggered on the falling (negative) edge

Procedure/requirements for channel A trigger sensitivity measurement:

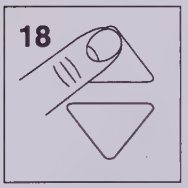


K Repeat steps G...I of step 15 for channel A.



L Repeat steps A...F of step 14 for channel A.

18. Timebase



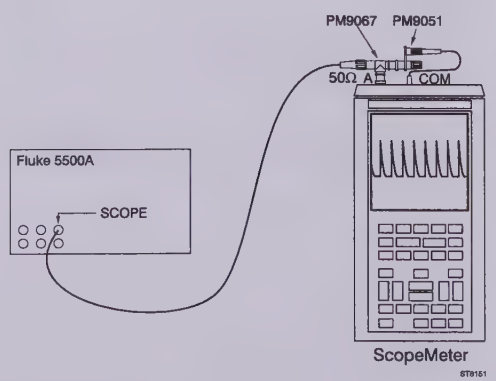
This test uses a marker pulse calibration signal to verify the deflection coefficient of the time base.

Test equipment:

Fluke 5500A Multi-Product Calibrator, mode SCOPE, MODE marker.

Test set-up:

Connect the banana jack COM to the BNC common



Procedure/requirements:

A Apply a 1 ms (1V peak-to-peak) time marker signal to the INPUT A BNC. Use a 50Ω termination.

B Verify that the distance between the 10th marker pulse and the 10th vertical grid line is the same as the distance between the 2nd marker pulse and the 2nd vertical grid line.
(Tolerance ± 1 pixel = ± 0,04 divisions)

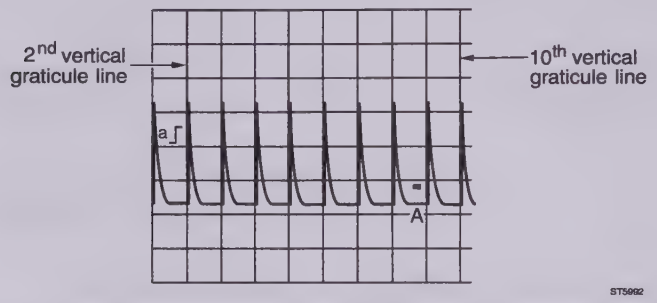
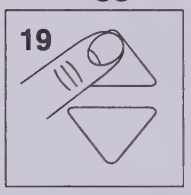


Figure 4.6 The distance between the 10th marker pulse and the 10th vertical grid line must be the same as the distance between the 2nd marker pulse and the 2nd vertical grid line

19. Trigger sensitivity external channel

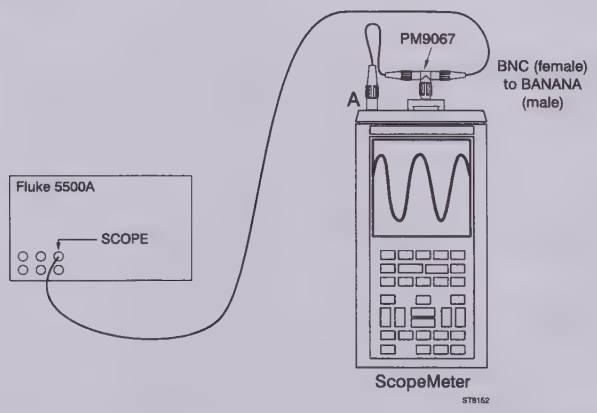


This test checks the trigger sensitivity, using the external banana connectors as the trigger input.

Test equipment:

Fluke 5500A Multi-Product Calibrator, mode SCOPE, MODE wavegen.

Test setup:



Procedure/requirements:

A Apply a 1 kHz sine wave signal, that has an amplitude of 1.8V peak-to-peak, superimposed on 1.4V DC to the INPUT A BNC and to the banana jack inputs. Use a coaxial T-piece and a BNC-to-banana converter (see test setup).

B Verify that the signal is well triggered.

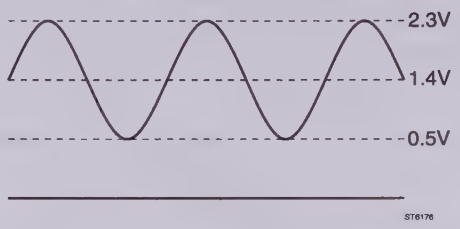
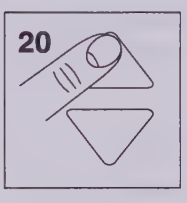


Figure 4.7 1.8V peak-to-peak sine wave superimposed on 1.4V DC

20. Horizontal deflection: x-deflection

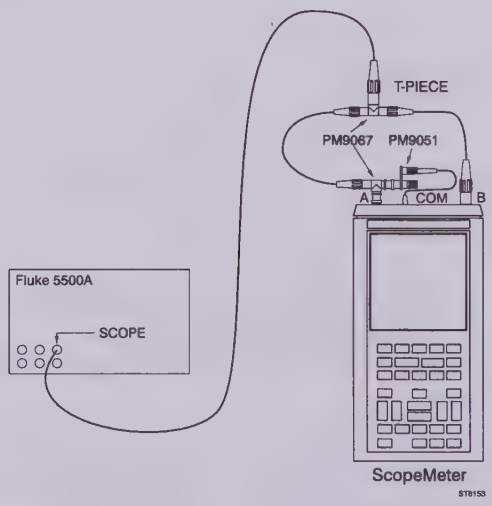


This test checks the correct working of the X-Y (A versus B) mode.

Test equipment:

Fluke 5500A Multi-Product Calibrator, mode SCOPE, MODE wavegen.

Test set-up:



Procedure:

A Apply a 2 kHz sine wave signal of 800 mV peak-to-peak to the INPUT A BNC and INPUT B BNC. Adjust the input signal to a trace height of 8 divisions.

Requirements:
Verify that a figure with an angle of 45° is displayed, and that the gap is smaller than 10 pixels. See figure 4.8.

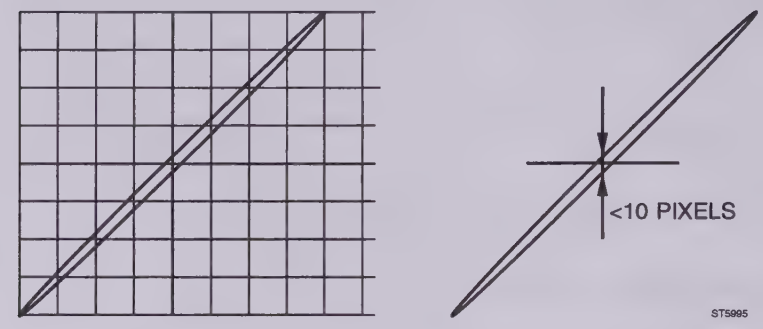
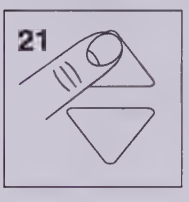


Figure 4.8 A versus B display

21/22. Base line instability

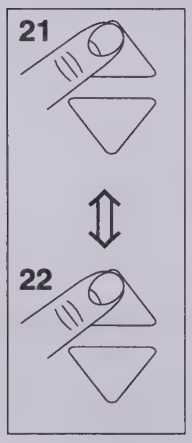


This test checks the maximum base line instability.

Test equipment:
none

Test setup:
no special setup required (open input).

Procedure/requirements:



A Turn off the signal sources connected to the ScopeMeter test tool input or minimize (zero) the signal amplitudes.

B Use the UP/DOWN keys to switch from front setting number 21 to number 22 and back to 21.

C Verify that the trace does not jump more than 0.2 divisions while switching between front settings 21 and 22.

23/24/25/26/27, TV TRIGGER

These tests check the TV trigger modes of the ScopeMeter test tools. For the tests of firmware version V8.20 you can only use a PAL video TV generator. Starting at firmware version V8.50 you can use a PAL, NTSC, or SECAM video TV generator, see section 4.1. For each system is an **appropriate** Figure.

Test equipment:

Philips PM5418 TV generator.

General settings:

TV signal generator:

Amplitude:	1 V peak-peak (5 div.).
Video system:	SECAM, NTSC, or PAL (grey scale)
Groma amplitude:	0
Connection:	Cable BNC to BNC PM9075
Terminator:	Feed through termination BNC to BNC from ITT-POMONA model 4119-75.

LINES MODE

A Apply the signal with the general settings and White Plane turned on.
B Use a 75Ω termination and 75Ω cable.
C Both line types (staircase and white area) should be visible, see Figure 4.9.

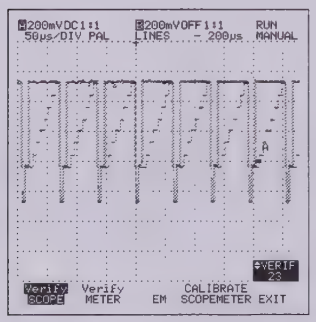


Figure 4.9a PAL

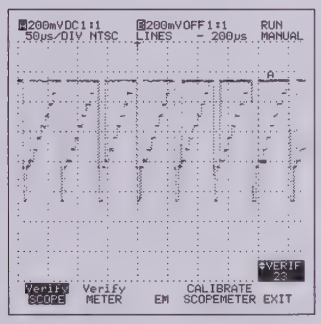


Figure 4.9b NTSC

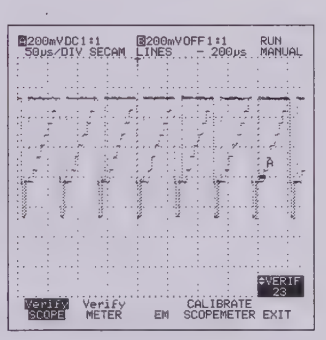
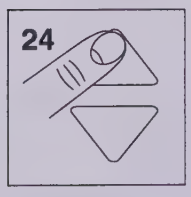


Figure 4.9c SECAM

NEGATIVE VIDEO



A Apply the signal with the general settings with a reversed polarity (So White Plane must be turned off). You can make reversed polarity by the use of two BNC to banana adapters, fore instance a PM9051 and a PM9053.
B Use a 75Ω termination and 75Ω cable.
C Line number 1 should be visible inverted, see Figure 4.10.

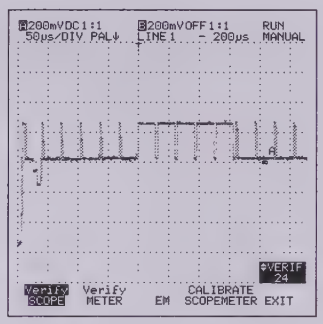

A200mVDC1:1 B200mVOFF1:1 RUN
50µs/DIV PAL LINE 1 - 200µs MANUAL
VERIF 24
Verify SCOPE Verify METER EM CALIBRATE SCOPEMETER EXIT

Figure 4.10a PAL

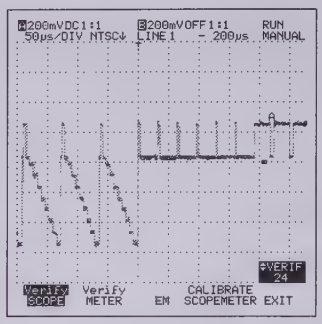

A200mVDC1:1 B200mVOFF1:1 RUN
50µs/DIV NTSC LINE 1 - 200µs MANUAL
VERIF 24
Verify SCOPE Verify METER EM CALIBRATE SCOPEMETER EXIT

Figure 4.10b NTSC

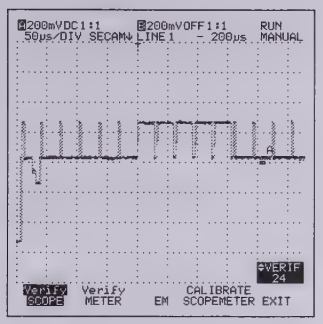
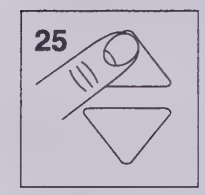

A200mVDC1:1 B200mVOFF1:1 RUN
50µs/DIV SECAM LINE 1 - 200µs MANUAL
VERIF 24
Verify SCOPE Verify METER EM CALIBRATE SCOPEMETER EXIT

Figure 4.10c SECAM

4- FIELD SEQUENCE 1



A Apply the signal with the general settings.
B Use a 75Ω termination and 75Ω cable.
C Check line number 313/263/313 is visible, see Figure 4.11.

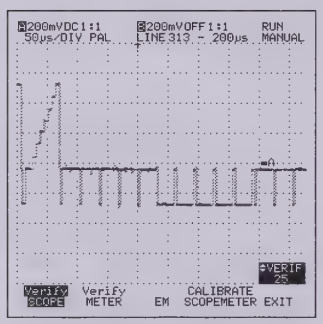

A200mVDC1:1 B200mVOFF1:1 RUN
50µs/DIV PAL LINE 313 - 200µs MANUAL
VERIF 25
Verify SCOPE Verify METER EM CALIBRATE SCOPEMETER EXIT

Figure 4.11a PAL

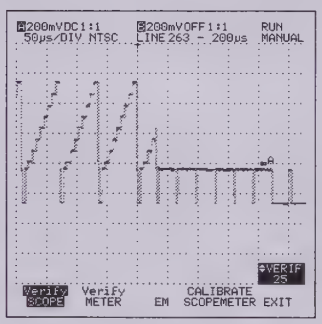

A200mVDC1:1 B200mVOFF1:1 RUN
50µs/DIV NTSC LINE 263 - 200µs MANUAL
VERIF 25
Verify SCOPE Verify METER EM CALIBRATE SCOPEMETER EXIT

Figure 4.11b NTSC

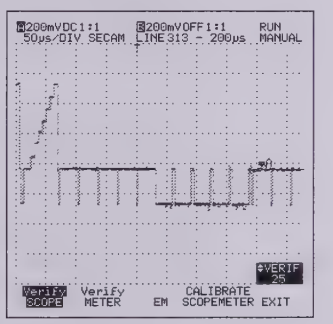
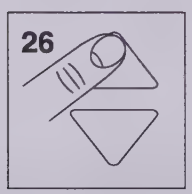

A200mVDC1:1 B200mVOFF1:1 RUN
50µs/DIV SECAM LINE 313 - 200µs MANUAL
VERIF 25
Verify SCOPE Verify METER EM CALIBRATE SCOPEMETER EXIT

Figure 4.11c SECAM

4- FIELD SEQUENCE 2



A Apply the signal with the general settings.
B Use a 75Ω termination and 75Ω cable.
C Check line number 625/525/625 is visible, see Figure 4.12.

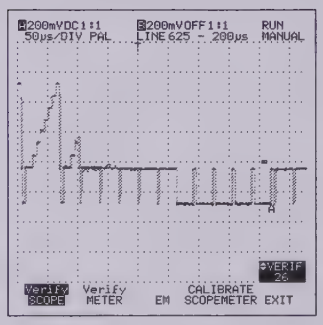

A200mVDC1:1 B200mVOFF1:1 RUN
50µs/DIV PAL LINE 625 - 200µs MANUAL
VERIF 26
Verify SCOPE Verify METER EM CALIBRATE SCOPEMETER EXIT

Figure 4.12a PAL

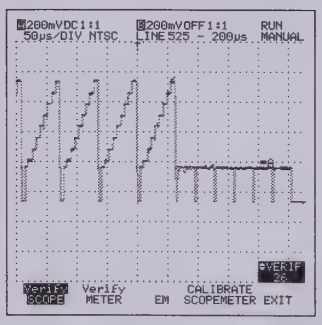

A200mVDC1:1 B200mVOFF1:1 RUN
50µs/DIV NTSC LINE 525 - 200µs MANUAL
VERIF 26
Verify SCOPE Verify METER EM CALIBRATE SCOPEMETER EXIT

Figure 4.11b NTSC

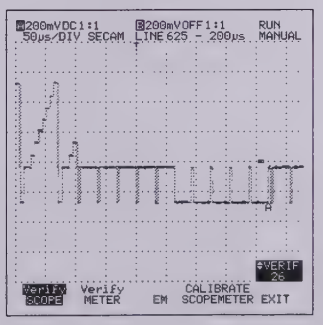
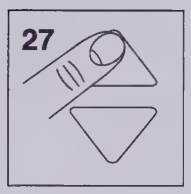

A200mVDC1:1 B200mVOFF1:1 RUN
50µs/DIV SECAM LINE 625 - 200µs MANUAL
VERIF 26
Verify SCOPE Verify METER EM CALIBRATE SCOPEMETER EXIT

Figure 4.11c SECAM

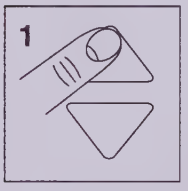
TV-OFF



A Apply the signal with the general settings.
B Use a 75Ω termination and 75Ω cable.
C Check the picture is not triggered (status line shows NOTRIG).

While in the SERVICE menu, press the METER softkey to enter the METER part of the Performance Verification Procedure.

1. Voltage accuracy METER mode



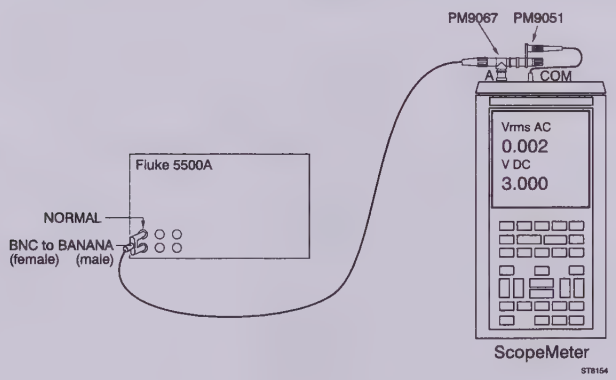
The following section checks the voltage accuracy in METER mode. The ScopeMeter test tool uses the same input circuitry (hardware) for the SCOPE (channel A) and the METER modes (in these attenuator settings). When the voltage accuracy of the METER is checked, the deflection coefficients for SCOPE channel A are also tested.

Test equipment:

Fluke 5500A Multi-Product Calibrator, mode NORMAL (SCOPE off).

Test setup:

Connect the banana jack COM to the BNC common



Procedure:

A Apply 300 mV DC to the INPUT A BNC.
B Change the input signal according to table 4.3 and check that the reading meets the requirements.

NOTE: The ScopeMeter test tool is set to METER "AUTORANGE" (step 1) with a dual (AC and DC) readout. This implies that the range is set automatically according to the input signal.

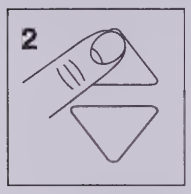
WARNING: After you have performed verification M1, deactivate the Fluke 5500A by pressing the STBY key, before touching the connection cables!

Requirements:

Table 4.3 Requirements for voltage accuracy test METER mode

Input signal	Requirements
300 mV DC	298.0...302.0V DC
300 mV RMS AC, 1 kHz	292.5...307.5V RMS AC
1V DC	0.990...1.010V DC
1V RMS AC, 1kHz	0.965...1.035V RMS AC
3V DC	2.980...3.020V DC
3V RMS AC, 1 kHz	2.925...3.075V RMS AC
30V DC	29.80...30.20V DC
30V RMS AC, 1 kHz	29.25...30.75V RMS AC
100V DC	099.0...101.0V DC
100V RMS AC, 1kHz	096.5...103.5V RMS AC

2. VOLTAGE accuracy EXT mV mode

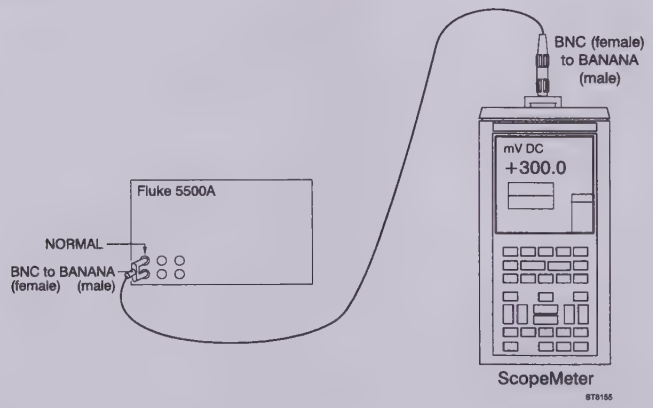


These tests check the accuracy of the EXT mV mode. The signal must be supplied to the banana jack inputs.

Test equipment:

Fluke 5500A Multi-Product Calibrator, mode NORMAL (SCOPE off).

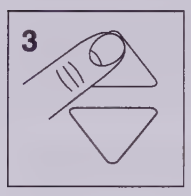
Test setup:



Procedure/requirements:

A Apply 300 mV DC to the banana jack inputs.
B Verify that the readout is between 298...302 mV DC.
C Apply 3V DC to the banana jack inputs.
D Verify that the readout is between 2.980...3.020V DC.
E Apply 250 mV RMS AC, 60 Hz to the banana jack inputs.
F Verify that the reading is between 243.5...256.5 mV AC.
G Apply 2V RMS AC, 60 Hz to the banana jack inputs.
H Verify that the reading is between 1.945...2.055V AC.

3. Resistance accuracy OHM mode

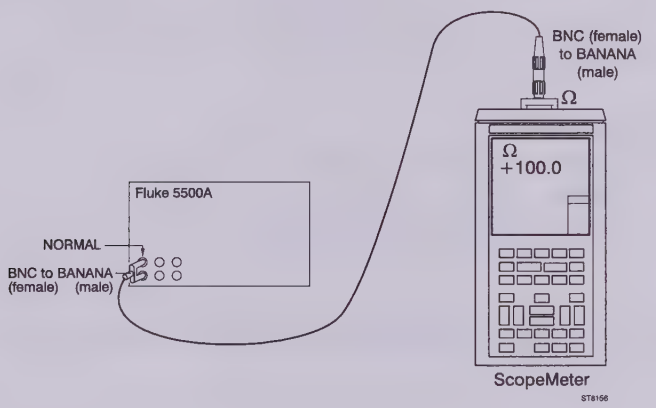


These tests check the accuracy of the OHM mode. The signal has to be supplied to the banana jack inputs.

Test equipment:

Fluke 5500A Multi-Product Calibrator, mode NORMAL (SCOPE off).

Test setup:



Procedure/requirements:

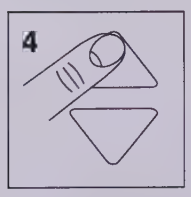
A Set the output of the Fluke 5500B to the values in table 4.4.

B Verify that the readings meet the requirements of listed in table 4.4.

Table 4.4 Requirements for Ohms accuracy test

Input signal	Requirements
0.0Ω (short)	000.0Ω...000.5Ω
100.0Ω	099.0Ω...101.0Ω
1.0 kΩ	0.990 kΩ...1.010 kΩ
10 kΩ	09.99 kΩ...10.10 kΩ
100 kΩ	099.0 kΩ...101.0 kΩ
1 MΩ	0.990 MΩ...1.010 MΩ
10 MΩ	09.90 MΩ...10.10 MΩ

4. Diode test mode accuracy

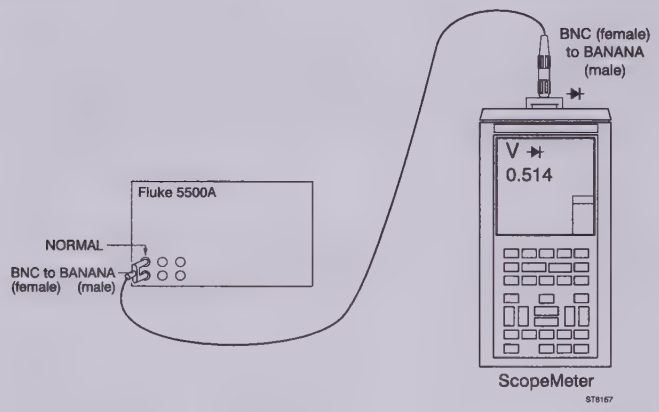


This test checks the accuracy of the Diode test mode.

Test equipment:

Fluke 5500A Multi-Product Calibrator, NORMAL mode (SCOPE off).

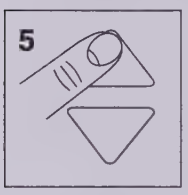
Test setup:



Procedure/requirements:

A Set the Fluke 5500A to 1V DC.
B Check that the readout is between 0.990...1.010 DC.

5. Signal display and frequency measurement



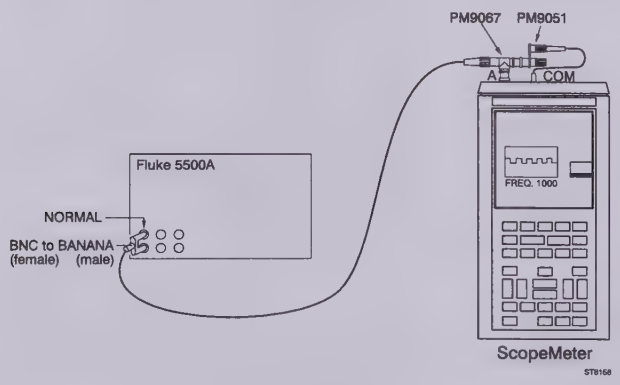
This test checks the waveform display and the frequency measurement function in METER MODE.

Test equipment:

Fluke 5500A Multi-Product Calibrator, NORMAL mode, WAVE square.

Test setup:

Connect the banana jack COM to the BNC common



Procedure/requirements:

A Apply a 1 kHz square wave, 6V peak-to-peak to the INPUT A BNC.
B Check that a stable (triggered) signal is displayed.
C Check that the frequency displayed is between 993...1007 Hz.

4.3 ADDITIONAL PERFORMANCE VERIFICATION PROCEDURE

This paragraph describes the Additional Performance Verification Procedure.
This procedure can be used to do some extra performance tests, depending on the ScopeMeter test tool model. Follow the instructions described with each step.

The recommended test equipment required for this Additional Performance Verification Procedure is listed in table 4.4.

Table 4.4 Recommended test equipment for Additional Performance Verification Procedure

Instrument Type	**Recommended Model**
Multi-Product Calibrator (with Scope option) Power Supply Multimeter	Fluke 5500A Philips PE1537 PM2525

- Cables and terminators for the Multi-Product Calibrator (all BNC type).
- Two standard banana test leads (delivered with the ScopeMeter test tool)
- 2 x BNC (female)-to-banana (male) adapter PM9081.
- 2 x BNC (male)-to-banana (female) adapter PM9051.
- T-piece PM9067.
- The red and grey probes, delivered **with** the ScopeMeter test tool.
- 5 mm Power Jack connector plug with attached cable (e.g.: 4822 321 20125)

NOTE: During the following Performance Verification Procedure, you must connect the ScopeMeter test tool inputs to the signal generator outputs. This connection must be made by coaxial cables (INPUT A or B BNC) or two standard banana test leads (banana jack inputs). The Additional Performance Verification Procedure does not use the oscilloscope probes delivered with the instrument. The calibration of the probes is described in the Operating Manual.

RESET

Before each additional verification procedure step the ScopeMeter test tool must be reset in the following way:

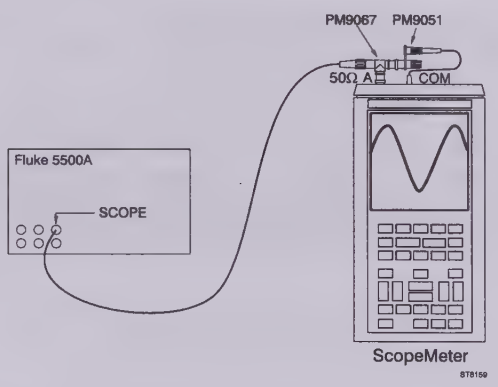
1 Turn the test tool off.
2 Press and hold the F1 key.
3 Press and release the ON-OFF key.
The test tool turns on, and you should hear a single beep.
input: A PROBE 1:1 appears on the display.
4 Release the F1 key.

1. Autoset

This test checks the correct operation of the AUTO SET function.

Test equipment:
Fluke 5500A Multi-Product Calibrator, mode SCOPE, MODE levsin.

Test setup:
Connect the banana jack COM to the BNC common



Settings/procedure/requirements:
A Reset the ScopeMeter test tool.
B Press the F1 key to select SCOPE mode.
C Apply a 50 MHz sine wave signal of 100 mV peak-to-peak to the INPUT A BNC. Use a 50Ω termination.
D Press the AUTO SET key. Check that the display is stable and well triggered. Minimal 2 and maximal 20 signal periods must be displayed, over 8 divisions. The signal amplitude must be approximately 5 divisions. The NOTRIG indication on the display must not flash.
E Repeat settings/procedure for the INPUT B BNC.

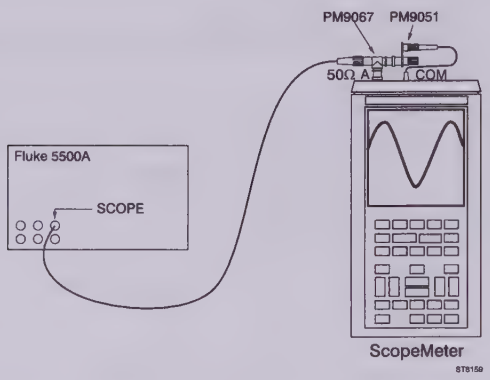
2. Vertical dynamic range and position range (move control)

This test checks the vertical dynamic range, together with the position range (move control). A certain overdrive of the ScopeMeter test tool must be allowed.

Test equipment:
Fluke 5500A Multi-Product Calibrator, mode SCOPE, MODE levsine.

Test setup:

Connect the banana jack COM to the BNC common



Settings/procedure/requirements for input A:

A Reset the ScopeMeter test tool.

Vertical dynamic range check:

B Press the F1 key to select SCOPE mode.

C Apply a 50 kHz sine wave signal of 950 mV peak-to-peak to the INPUT A BNC. Use a 50Ω termination.

D Press the AUTO SET key. Set INPUT A to 100 mV/div. and set the timebase speed to 10ms/div.

E Use the vertical MOVE key to shift the bottom of the sine wave vertically over the screen in the lower division. Shift the top of the sine wave in the upper division. Verify that the top and bottom of the sine wave signal of 9.5 divisions can be displayed distortion free.

F Apply a 60 MHz sine wave signal of approximately 500 mV peak- to-peak (4 divisions on the screen) to the FL92B, FL96B and a 100 MHz signal to the FL99B, FL105B INPUT A BNC. Use a 50Ω termination.

G Set the timebase speed to a speed of 10 ns/div for the FL92B, FL96B and 5 ns/div for the FL99B, FL105B.

H Now a sine wave with an amplitude of 4 divisions must be displayed distortion free.

Move control check:

A Adjust the signal amplitude to 8 divisions on the screen.

B Check that the trace can be moved over 4 divisions up (+ 4 div.) and over 4 divisions down (-4 div.).

Settings/procedure/requirements for input B:

Repeat the total procedure for input B.

3. Trigger level control range

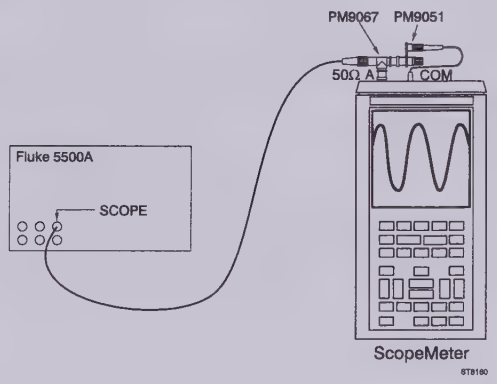
This test checks the trigger level control range.

Test equipment:

Fluke 5500A Multi-Product Calibrator, mode SCOPE, MODE levsine.

Test setup:

Connect the banana jack COM to the BNC common



Settings/procedure/requirements

A Reset the test tool.

B Press the F1 key to select SCOPE mode.

C Apply a 500 kHz sine wave with an amplitude of 950 mV peak-to-peak to the INPUT A BNC. Use a 50Ω termination.

D Press the AUTOSET key and verify that the signal is well triggered.

E Set the INPUT attenuation to 100 mV/div., and the time base to 500 ns/div.

F Press the TRIGGER key and then the F5 key (ADJUST LEVEL). Adjust the trigger level with the ▲ and the ▼ keys.
Verify that the signal is well triggered over a trigger level range of 8 divisions (4 divisions up, and 4 divisions down).
The trigger level value is displayed. The trigger level marker (AI) will shift while adjusting the trigger level. See figure 4.13

G Repeat the same procedure for INPUT B.

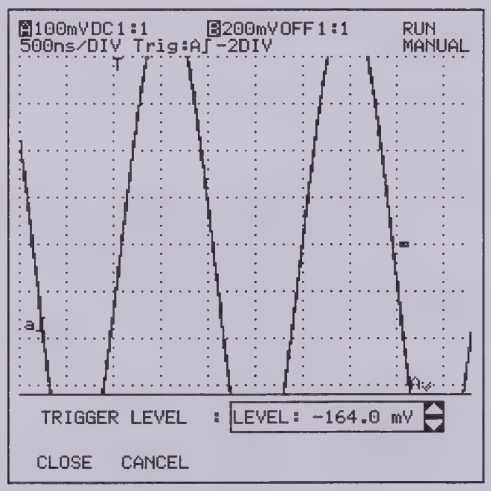


Figure 4.13 Trigger level control

5 CALIBRATION ADJUSTMENT PROCEDURE

5.1 GENERAL INFORMATION

The following information provides the complete Calibration Adjustment Procedure for the ScopeMeter test tool. Because various control functions are interdependent, a certain order of adjustment is necessary. The procedure is therefore presented in a sequence that is best suited to this order. Before you make calibration adjustments, always use the Performance Verification Procedure in chapter 4 to check the ScopeMeter test tool performance.

The Calibration Adjustment Procedure, described here, consists of the following three parts:

- CONTRAST Calibration Adjustment Procedure
- SCOPE Calibration Adjustment Procedure
- METER Calibration Adjustment Procedure

Almost all Calibration Adjustments can be done without opening the instrument. Only the first four steps of the SCOPE Calibration Adjustment Procedure require Disassembling of the ScopeMeter test tool (see section 5.6.1).

NOTE: Every year use the Performance Verification Procedure in chapter 4 to check the test tool. If it fails the Performance Verification Procedure, Calibration Adjustments must be made. If it also fails the Calibration Adjustment Procedure, repair is necessary (see chapter 7). (After repair, it is sometimes also necessary to do also a Hardware Calibration Adjustment, see section 5.6.1)

Sections 5.5, 5.6 and 5.7 describe the calibration process in detail. Section 5.8 contains a summary of all calibration adjustments as a reference for more frequent users.

5.2 RECOMMENDED CALIBRATION ADJUSTMENT EQUIPMENT

The equipment recommended for the Calibration Adjustment Procedure is listed in table 5.1.

All calibration adjustments must be done in ambient temperatures between 18 °C and 28 °C. Allow the ScopeMeter test tool to warm up for at least 20 minutes.

Table 5.1 Recommended calibration adjustment equipment survey

Instrument Type	**Recommended Model**
Multi-Product Calibrator	Fluke 5500A with scope option
*) Personal Computer	Any IBM compatible PC, running MS-DOS
*) Optical to RS-232 Interface Cable	PM9080/001
*) Flash ROM Refresh software	Contact your Service Center
*) +12V (± 2.5%) Programming voltage	

*) These items are required after two or three calibrations, see note paragraph 5.3, page 5-3 for details.

- Cables and terminators for the Multi-Product Calibrator (all BNC type).
- Standard banana test leads.
- Two banana test leads are delivered with the ScopeMeter test tool.
- 2 x BNC (female)-to-banana (male) adapter PM9081.
- 2 x BNC (male)-to-banana (female) adapter PM9051.
- 2 x T-piece PM9067.
- The red and grey probes, delivered **with** the ScopeMeter test tool.

5.3 ENTERING THE CALIBRATION PROCEDURE

The Calibration Adjustment Procedure is operated via built-in sequences. Before you can activate a calibration sequence, you must first connect a 12V DC programming voltage to the ScopeMeter test tool. To do this, first remove the battery pack. See section 6.2.1.

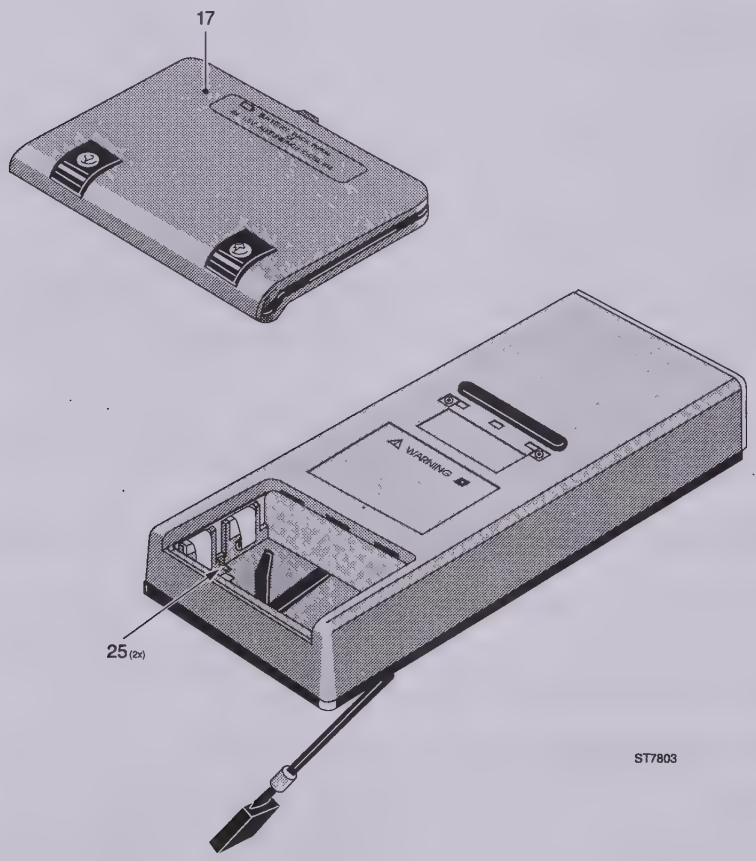


Figure 5.1 Position of the +12V and 0 contacts for calibration (items 25)

If you have removed the battery pack and the battery cover (figure 5.1, item 17), you will have access to the +12V/0 contacts (figure 5.1, item 25). These contacts are placed in the left middle (+12V) and the right middle (0) of the battery compartment. Connect +12V DC to the contact marked "+12V" and 0V to the contact marked "0".

CAUTION: To avoid damaging the Flash ROM circuitry be sure to apply the polarity of 12V programming voltage correctly.

NOTE: After you have performed the Calibration Procedure, remove the 12V programming voltage. Do not perform measurements with the ScopeMeter test tool, while the programming voltage is still present.

Connect the test tool to the Power Adapter/Battery Charger PM 8907 and turn on the power. Now press the BACKLIGHT key, then press AUTOSET, and then release the BACKLIGHT key. This will start the SERVICE menu (see figure 4.1, chapter 4). This menu allows you to start the calibration sequence. Press the corresponding function key marked "CALIBRATE ScopeMeter test tool". This will start the CALIBRATE menu.

NOTE: If there is not enough space in the FLASH memory you get a message on the display.

After two or three electronic calibrations (see NOTE above), the ScopeMeter test tool will display a message that the internal Flash ROMs are full. To enable another calibration, you must first empty the Flash ROMs and reinstall the operating software. To do this, send the ScopeMeter test tool to your nearest Service Center. It is also possible to "refresh" the FlashROMs by yourself, using a PC. For more information: contact your nearest Service Center.

5.4 OPERATING THE CALIBRATION PROCEDURE

Function keys in the CALIBRATE menu
In the CALIBRATE menu, it is possible to choose the calibration mode (sequence) to be performed.

Press the function key marked:
- CONTRAST for the CONTRAST Calibration Adjustment Procedure (see section 5.5).
- SCOPE for the SCOPE Calibration Adjustment Procedure (see section 5.6).
- METER for the METER Calibration Adjustment Procedure (see section 5.7).

When one of these three calibration sequences is chosen, the corresponding text on the screen will be shown in reverse. This shows that this calibration mode is active.

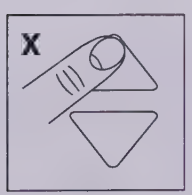
If you press the ESCAPE softkey, the ScopeMeter test tool will leave the CALIBRATE menu and return to the SERVICE menu.

NOTE: If you use the ESCAPE softkey to leave the SERVICE menu before storing the new calibration values with the CAL STORE softkey, you will lose all new calibration values. The instrument will continue using the calibration values that were used before entering the CALIBRATE menu.

The CAL STORE function key saves the new calibration values that are obtained in the CONTRAST, SCOPE or METER sequences, to the Flash ROM. From the moment you press the CAL STORE function key, the ScopeMeter test tool uses the new calibration data. The old calibration data is no longer valid. This will also fill one calibration field in the Flash ROM. See section 5.3.

NOTE: After calibrating the ScopeMeter test tool, reset the instrument (use a MASTER RESET), before performing measurements. A MASTER RESET is done when the test tool is turned on while the F5 function key is depressed. Two beeps are audible.

Keys in CONTRAST, SCOPE, or METER Calibration mode
The calibration is presented as a sequence. You can advance through this sequence by pressing the UP/DOWN keys. Pressing the UP ▲ key advances one step; pressing the DOWN ▼ key brings you back one step.



In sections 5.5, 5.6 and 5.7 this figure is used to indicate that the UP or DOWN key must be pressed to choose the indicated step number "x".

When the ScopeMeter test tool LCD displays the indication " CAL", you must first apply the appropriate input (calibration) signal. When the correct signal is present at the correct terminal, you start the built-in calibration by pressing the most right READY function key. The text "READY" will be in reverse video, to show that the internal calibration is active. When the process is ready, the "READY" text will change again, from inverted to normal. Now you can use the UP key to advance to the next calibration step or the DOWN key to return to a previous calibration step.

After you have completed a calibration sequence, press either the CONTRAST, SCOPE, METER or ESCAPE function key again to return to the CALIBRATE menu. The new calibration data will stay in memory to enable you to store it permanently with the CAL STORE function key.

Press the ESCAPE function key twice to leave the active calibration mode without storing the new calibration data. This will also return you to the SERVICE menu.

5.5 CONTRAST CALIBRATION ADJUSTMENT PROCEDURE

You activate the CONTRAST Calibration Adjustment Procedure from the CALIBRATE menu, by pressing the left most CONTRAST function key. When this function key is depressed, the text "CONTRAST" is shown in reverse video, to show that this calibration mode is active.

Now use the UP/DOWN keys to adjust the contrast of the LCD to your own (personal) setting. When you have found the correct setting, you can make this setting ready for calibration storage, by pressing the READY softkey once.

NOTE: When you press the READY function key, this does not mean that the new value of the LCD contrast is actually stored in the Flash ROMs of the ScopeMeter test tool. This only happens when you press the CAL STORE function key.

Press the CONTRAST function key again to leave the CONTRAST Calibration Adjustment Procedure. The text "CONTRAST" will change from reverse video into normal again.

5.6 SCOPE CALIBRATION ADJUSTMENT PROCEDURE

You can start the SCOPE Calibration Adjustment Procedure from the CALIBRATE menu by pressing the SCOPE function key. When this function key is pressed, the text "SCOPE" is shown in reverse video, to show that this calibration mode is active.

The SCOPE Calibration Adjustment Procedure is divided into two parts:

- Hardware SCOPE Calibration Adjustments: steps H1 to H4
- Closed Case SCOPE Calibration Adjustments: steps S5 to S29

NOTE: During the following Calibration Adjustment Procedure, you must connect the ScopeMeter test tool inputs to the signal generator outputs by means of coaxial cables (input A or B) or two standard banana test leads (banana jack inputs).

5.6.1 Hardware SCOPE Calibration Adjustments

The first four steps of the SCOPE Calibration Adjustment Procedure are called Hardware SCOPE Calibration Adjustments. To perform the Hardware SCOPE Calibration Adjustments, you must open the ScopeMeter test tool. The disassembly procedure for these calibration adjustments is described in chapter 6 (section 6.1 and 6.2.3).

WARNING: To prevent personal injury, do not perform any disassembly procedures before reading chapter 6.

When the ScopeMeter test tool is disassembled, it is not possible to apply the +12V programming voltage in the normal way. It is possible to apply the +12V programming voltage by means of two test clips (see figure 5.2).

Remove all voltage sources from the ScopeMeter test tool. Turn the digital A1 PCB, mounted in the top cover so that the display and the keyboard are facing down. Connect the +12V programming voltage to the appropriate places on the PCB. It can be helpful to first install two metal screws again. See figure 5.2.
Turn the top cover and the mounted PCB. Connect the ScopeMeter test tool to the power supply and turn the instrument on. Go to the SERVICE menu and press the CALIBRATE function key. You can make the adjustments necessary with six trim capacitors (three for the attenuator of each channel) and two adjustment potentiometers (for the Analog ASIC).

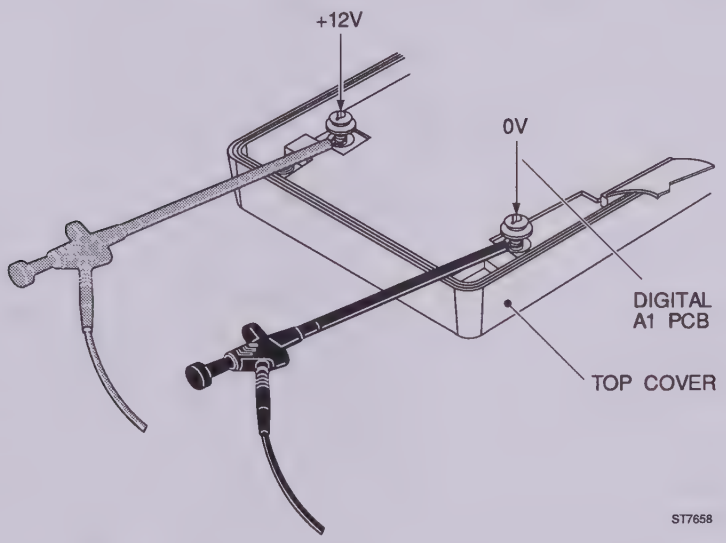


Figure 5.2 Connecting the +12V programming voltage for Hardware SCOPE Calibration Adjustments

NOTE: You only have to do Hardware SCOPE Calibration Adjustments, if you have repaired the ScopeMeter test tool in the Attenuator sections or in the Analog ASIC circuitry. After you have done a Hardware SCOPE Calibration Adjustment or you have adjusted one of the potentiometers, you always need to do a full (software) SCOPE and METER calibration. If you decide not to do the Hardware Calibration Adjustment now, you can advance to calibration S5 by pressing the UP key 4 times.

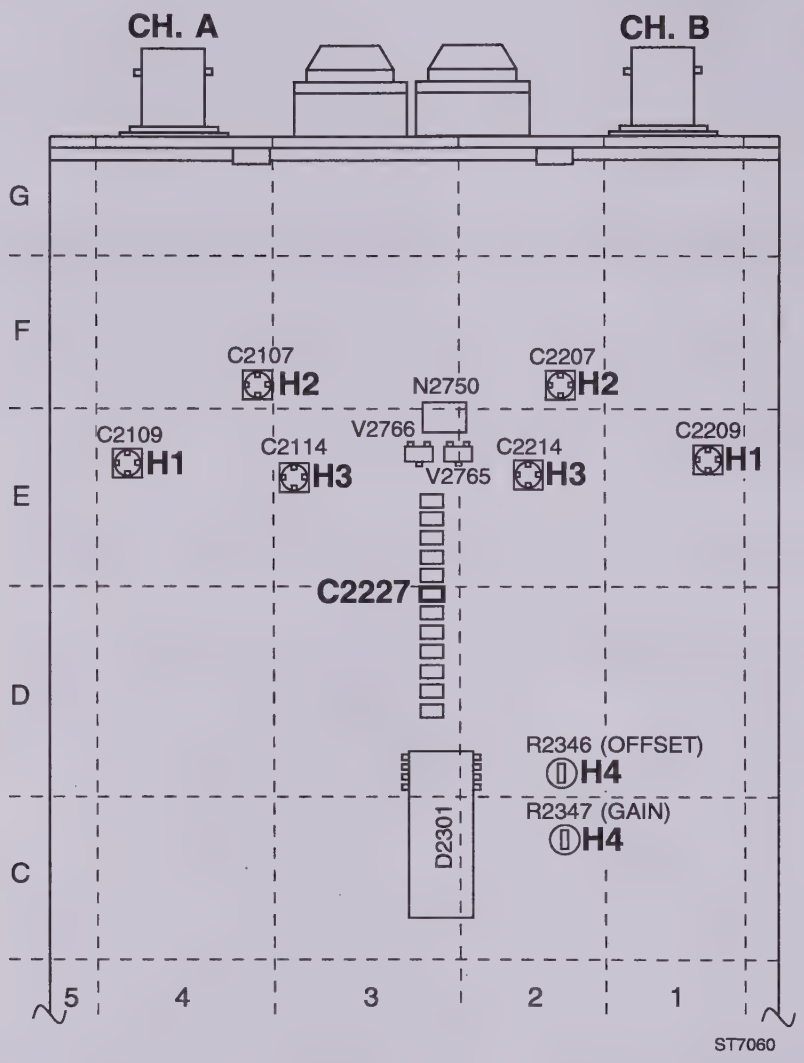
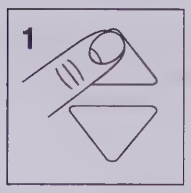


Figure 5.3 Analog A2 PCB; position of hardware adjustment trimmers and potentiometers

H1. Hardware pulse response of the *1 attenuation



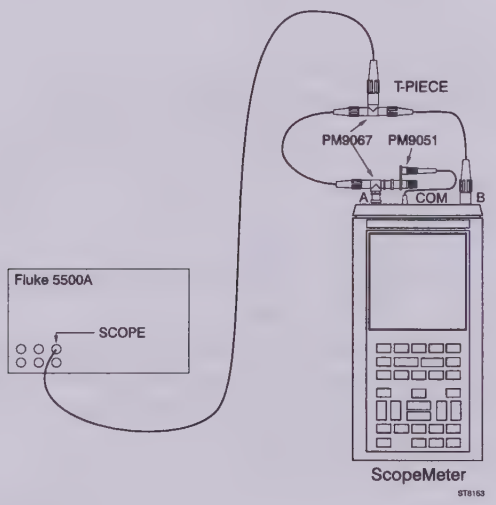
Purpose: optimal pulse response of the *1 attenuation circuit.

Calibration equipment:

Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE volt

Calibration setup:

- Connect the banana jack COM to the BNC common



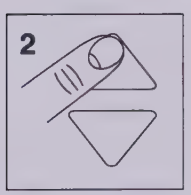
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 300 mV peak-to-peak (signal between 0 mV and +300 mV) to the INPUT A BNC and the INPUT B BNC.

B - Turn trimmer C2209 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2209 can be found in figure 5.3.

C - Turn trimmer C2109 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2109 can be found in figure 5.3.

H2. Hardware pulse response of the *10 attenuation



Purpose: optimal pulse response of the *10 attenuation circuit.

Calibration equipment:

Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE volt

Calibration setup:

See calibration setup H1.

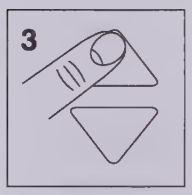
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 3V peak-to-peak (signal between 0V and +3V) to the INPUT A BNC and the INPUT B BNC.

B - Turn trimmer C2207 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2207 can be found in figure 5.3.

C - Turn trimmer C2107 on the analog A2 PCB to get the best channel B pulse response on the LCD. The position of trimmer C2107 can be found in figure 5.3.

H3. Hardware pulse response of the *100 attenuation



Purpose: optimal pulse response of the *100 attenuation circuit.

Calibration equipment:

Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE volt.

Calibration setup:

See calibration setup H1.

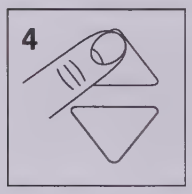
Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 30V peak-to-peak (signal between 0V and + 30V) the INPUT A BNC and the INPUT B BNC.

B - Turn trimmer C2214 on the analog A2 PCB to get the best channel A pulse response on the LCD (least distorted waveform). The position of trimmer C2214 can be found in figure 5.3.

C - Turn trimmer C2114 on the analog A2 PCB to get the best channel B pulse response on the LCD.
The position of trimmer C2114 can be found in figure 5.3.

H4. Hardware offset and gain



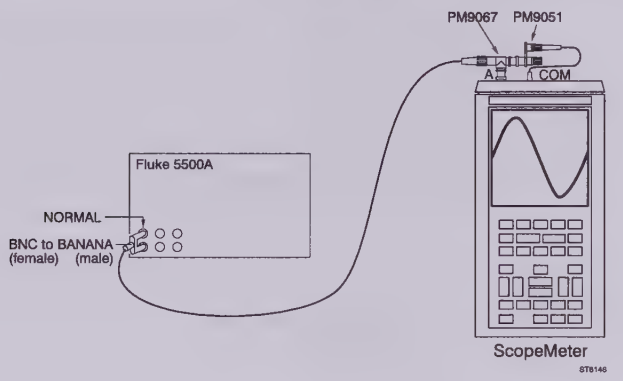
Purpose: optimal response of complete analog A2 circuitry.

Calibration equipment:

Fluke 5500A Multi-Product Calibrator, output NORMAL.

Calibration setup:

Connect the banana jack COM to the BNC common



Procedure:

A - Connect Test Point TP209 on the analog A2 PCB to GROUND. The position of Test Point TP209 can be found in section 9: figure 9.4 (A2 PCB layout wired components side). Instead of connecting TP209 to GROUND you can shortcircuit C2227 (e.g. with a pair of tweezers). The position of C2227 can be found in figure 5.3.

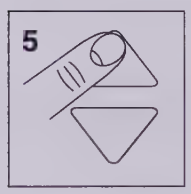
B - Apply a 1 kHz sine wave signal with an amplitude of 720 mV AC peak-to-peak to the INPUT A BNC. (Set the Fluke 5500A to 254.56 mV RMS, 1 kHz sine wave.)

C - Turn the potentiometers R2346 and R2347 so that the sine wave on the LCD is exactly 6 divisions: maximum (peak) on +3 divisions, minimum (peak) on -3 divisions (tolerance

5.6.2 Closed Case SCOPE Calibration Adjustments

NOTE: The following calibration adjustments are done electronically. For these calibrations, the ScopeMeter test tool must be in a fully assembled state!

S5. Offset correction

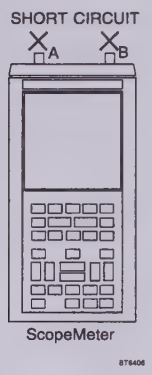


Purpose: remove offset of channel A and B input operational amplifiers.

Calibration equipment:

none.

Calibration setup:

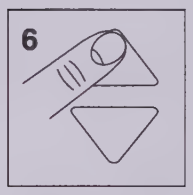


Procedure:

A - Short circuit the INPUT A BNC and the INPUT B BNC. You can use the PM9051 BNC to banana adapter with interconnected banana sockets.

B - Press the READY function key.

S6/7. Pulse response of the *1/*10 attenuation (fine adjustments)



Purpose: optimal pulse response of the *1, *10 attenuation circuit.

Calibration equipment:

Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE volt

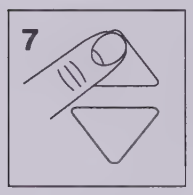
Calibration setup:

See calibration setup H1.

Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 300 mV peak-to-peak (signal between 0 mV and +300 mV) to the INPUT A BNC and the INPUT B BNC.

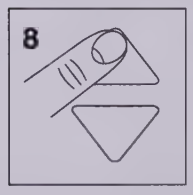
B - Press the READY function key.



C - Apply a square wave with a frequency of 1 kHz, amplitude 3V peak-to-peak (signal between 0V and +3V) to the INPUT A BNC and the INPUT B BNC.

D - Press the READY function key.

S8/9. Pulse response of the *100/*1000 attenuation (fine adjustments)

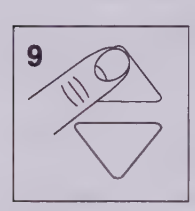


Purpose: optimal pulse response of the *100, *1000 attenuation circuit.

Calibration equipment:
Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE volt

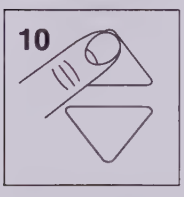
Calibration setup:
See calibration setup H1.

Procedure:
A - Apply a square wave with a frequency of 1 kHz, amplitude 20V peak-to-peak (between 0V and +20V) to the INPUT A BNC and the INPUT B BNC.
B - Press the READY function key.



C - Apply a square wave with a frequency of 1 kHz, amplitude 50V peak-to-peak (between 0V and +50V) to the INPUT A BNC and the INPUT B BNC.
D - Press the READY function key.

S10/11/12/13/14/15/16/17
Gain for 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 2V, 20V



Purpose: correction of the system gain (from BNC to microprocessor) in attenuator settings: 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 2V, 20V.

Calibration equipment:
Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE volt

Calibration setup:
See calibration setup H1.

Procedure:
A - Apply a square wave with a frequency of 1 kHz, amplitude 20 mV peak-to-peak to the INPUT A BNC and the INPUT B BNC.
B - Press the READY function key.
C - Change the input voltage according to table 5.2.
After each calibration press the READY function key. Use the UP/DOWN keys to advance/go back in the list.

NOTE: These steps calibrate both channel A and B at the same time.

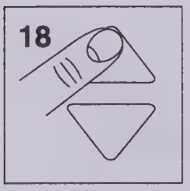
NOTE: The frequency of the square-wave must be 356Hz during calibration of step 17.

WARNING: After you performed S17 deactivate the Fluke 5500A with the STBY key before touching the cables.

Table 5.2 Calibration signals for step S10...S17

Calibration step number	Calibration voltage
S10	square wave, 1 kHz, 20 mV peak-to-peak
S11	square wave, 1 kHz, 50 mV peak-to-peak
S12	square wave, 1 kHz, 100 mV peak-to-peak
S13	square wave, 1 kHz, 200 mV peak-to-peak
S14	square wave, 1 kHz, 500 mV peak-to-peak
S15	square wave, 1 kHz, 1V peak-to-peak
S16	square wave, 1 kHz, 10V peak-to-peak
S17	square wave, **356** Hz, 100V peak-to-peak

S18/19. Shift gain *1 mode and /8 mode



Purpose: correct for the shift gain in "times 1 mode" and in "divided by 8 mode".

Calibration equipment:

Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE volt.

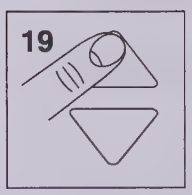
Calibration setup:

See calibration setup H1.

Procedure:

A - Apply a square wave with a frequency of 1 kHz, amplitude 200 mV peak-to-peak (signal between 0 mV and +200 mV) to the INPUT A BNC and the INPUT B BNC.

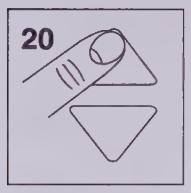
B - Press the READY function key.



C - Apply a square wave with a frequency of 1 kHz, amplitude 20 mV peak-to-peak (between 0 mV and +20 mV) to the INPUT A BNC and the INPUT B BNC.

D - Press the READY function key.

S20/21/22/23. Channel A and channel B 50% and 90% trigger level

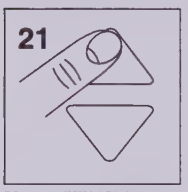


Purpose: calibrate the 50% and 90% analog trigger level of channel A and channel B.

Calibration equipment:
Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE wavegen.

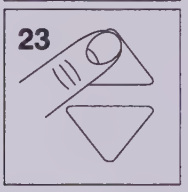
Calibration setup:
See calibration setup H1.

Procedure:
A - Apply a sine wave with a frequency of 10 kHz, amplitude 2V peak-to-peak to the INPUT A BNC and INPUT B BNC.
B - Press the READY function key.



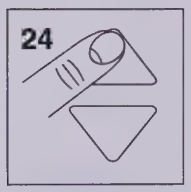
C - Press the READY function key.

D - Press the READY function key.



E - Press the READY function key

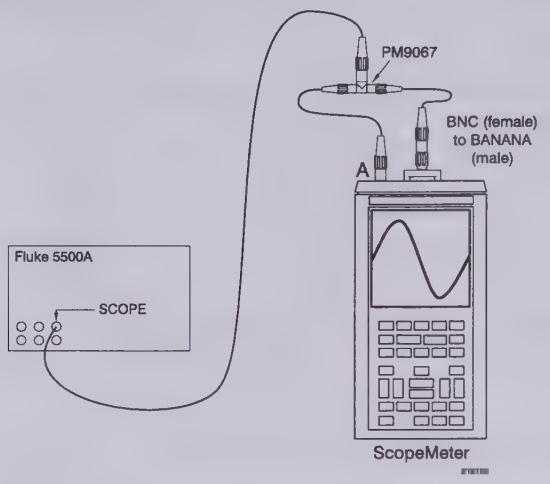
S24. External triggering



Purpose: calibrate the 0.2V external trigger level.

Calibration equipment:
Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE wavegen

Calibration setup:

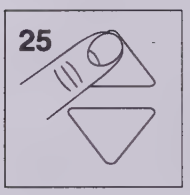


Procedure:

A - Apply a 10 kHz sine wave signal with an amplitude of 2V peak-to-peak to the INPUT A BNC and also to the banana jack inputs. Use a T-piece and a BNC (female)-to-banana (male) adapter (see calibration setup).

B - Press the READY function key.

S25. Random sampling



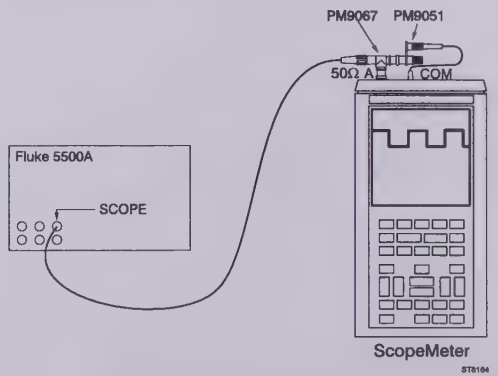
Purpose: calibration of the random sampling levels.

Calibration equipment:

Fluke 5500A Multi-Product Calibrator, SCOPE mode, MODE edge.

Calibration setup:

Connect the banana jack COM to the BNC common



Procedure:

A - Apply a 1 MHz square wave signal with an amplitude 550 mV peak-to-peak to channel A. Use a 50Ω termination.
B - Press the READY function key.
C - Now press the SCOPE function key to go back to the CALIBRATE menu.

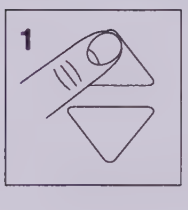
Continue with the meter calibration adjustment procedure, section 5.7

5.7 METER CALIBRATION ADJUSTMENT PROCEDURE

Press the METER function key to activate the METER Calibration Adjustment Procedure from the CALIBRATE menu. When you press this function key, the text "METER" will be shown in reverse video to show that this calibration mode is active.

NOTE: During the METER calibration, the values displayed on the LCD do not represent the values of the input voltages!

M1. Linearity calibration and M2. Zeroing the ranges



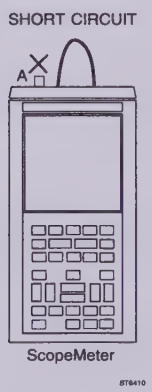
Purpose M1: calibration of the linearization table, used by the ScopeMeter test tool.

Purpose M2: this calibration zeros all ranges of the ScopeMeter test tool in METER mode: 300 mV, 3V, 30V and 300V on the INPUT A BNC and 300 mV and 3V of the banana input jacks.

Calibration equipment:

none

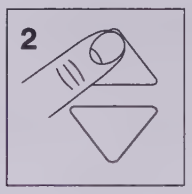
Calibration set-up:



Procedure:

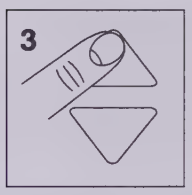
A - Short circuit the INPUT A BNC and the banana jacks inputs. For this you can use the adapter PM9051 with interconnected banana sockets.
B - Press the READY function key.

NOTE: During this calibration step many internal calibration constants are being set. This process can last up to 3 minutes.



C - Short circuit the INPUT A BNC and the banana jack inputs.
D - Press the READY function key.

M3. Channel A, 300 mV range: zero for open input



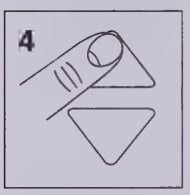
Purpose: zero channel A in the 300 mV range with open input.

Calibration equipment:
none

Calibration setup:
INPUT A BNC open.

Procedure:
A - Remove any connection from the INPUT A BNC.
B - Press the READY function key.

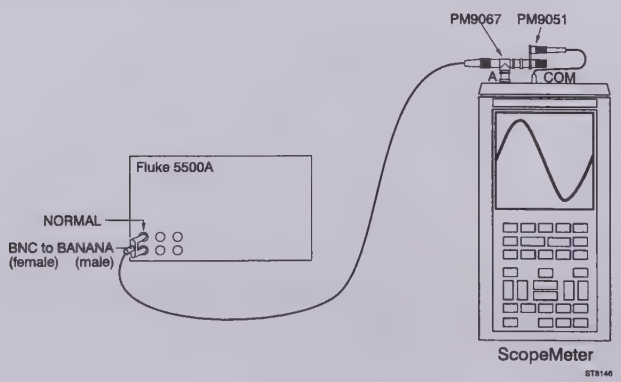
M4/5/6/7. Channel A, 300 mV/3V/30V/300V range: gain calibration



Purpose: calibration of the channel A gain in the 300 mV, 3V, 30V and 300V ranges.

Calibration equipment:
Fluke 5500A Multi-Product Calibrator, output NORMAL (SCOPE off).

Calibration setup:
Connect the banana jack COM to the BNC common



Procedure:

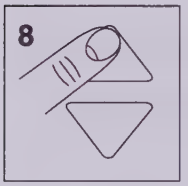
WARNING: After you performed M7 deactivate the Fluke 5500A with the STBY key before touching the cables.

A - Apply 300 mV, 0Hz DC to the INPUT A BNC.
B - Press the READY function key.
C - Change the input voltage according to table 5.3. After each calibration press the READY function key.
Use the UP/DOWN keys to advance/go back in the list.

Table 5.3 Calibration signals for step M4...M7

Calibration Step Number	Calibration Voltage
M4	300 mV DC
M5	3V DC
M6	30V DC
M7	300V DC

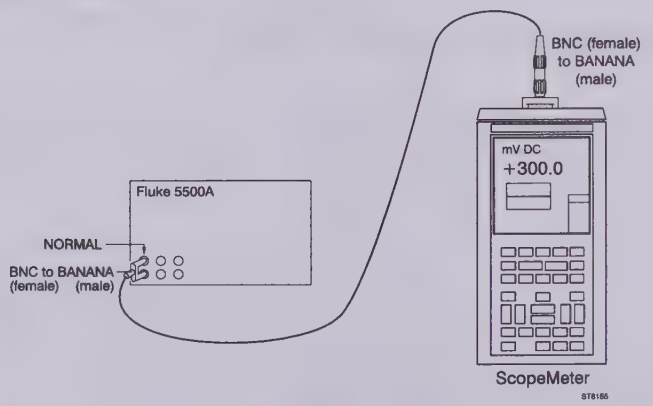
M8/9. EXT mV mode, 300 mV/3V range: gain calibration



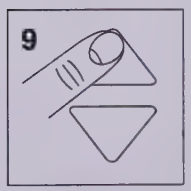
Purpose: calibration of the EXT mV mode gain in the 300 mV and 3V ranges.

Calibration equipment:
Fluke 5500A Multi-Product Calibrator, output NORMAL (SCOPE off).

Calibration setup:

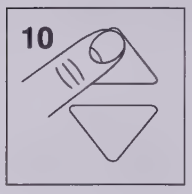


Procedure:
A - Apply 300 mV DC to the banana connectors. Use a coaxial cable and 2 PM9081 adapters.
B - Press the READY softkey.



C - Apply 3V DC to the banana jack inputs.
D - Press the READY function key.

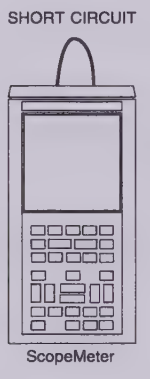
M10. All ranges 0Ω calibration



Purpose: calibration of the 0Ω points in all ranges.

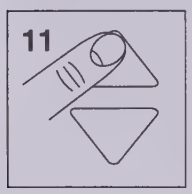
Calibration equipment:
none

Calibration setup:



Procedure:
A - Short circuit the banana jack inputs.
B - Press the READY function key.

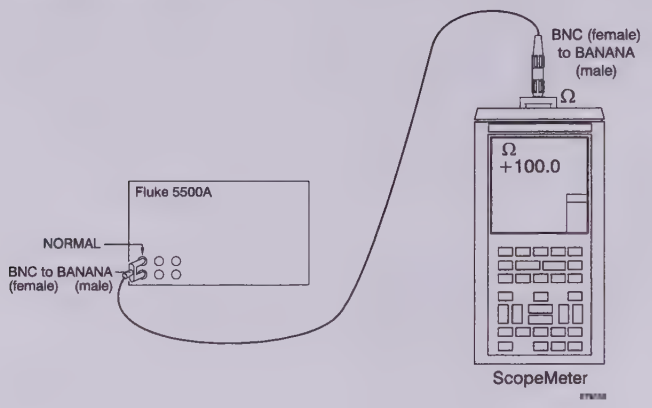
M11/12/13/14/15/16. Calibration of the Ohm ranges



Purpose: calibration of the 30Ω, 300Ω, 3 kΩ, 30 kΩ, 300 kΩ, 3 MΩ, and 30 MΩ ranges.

Calibration equipment:
Fluke 5500A Multi-Product Calibrator, output NORMAL (SCOPE off).

Calibration setup:



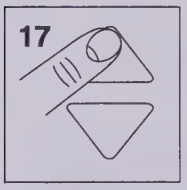
Procedure:

A - Connect 100Ω to the banana jack inputs.
B - Press the READY function key.
C - Change the resistance according to table 5.4. After each calibration press the READY function key. Use the UP/DOWN keys to advance/go back in the list.

Table 5.4 Calibration signals for step M11...M16

Calibration Step Number	Calibration Resistance
M11	100Ω
M12	1 kΩ
M13	10 kΩ
M14	100 kΩ
M15	1 MΩ
M16	10 MΩ

M17. Voltage ramp calibration

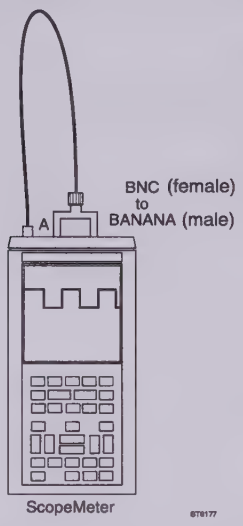


Purpose: calibration of the voltage ramp of the component tester.

Calibration equipment:

none

Calibration setup:

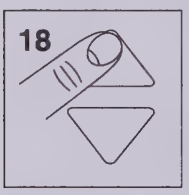


Procedure:

A - Connect the INPUT A BNC to the red GENERATOR OUT banana jack, by means of a BNC cable and a BNC (female)-to- banana(male) connector.

B - Press the READY function key.

M18. Current ramp calibration

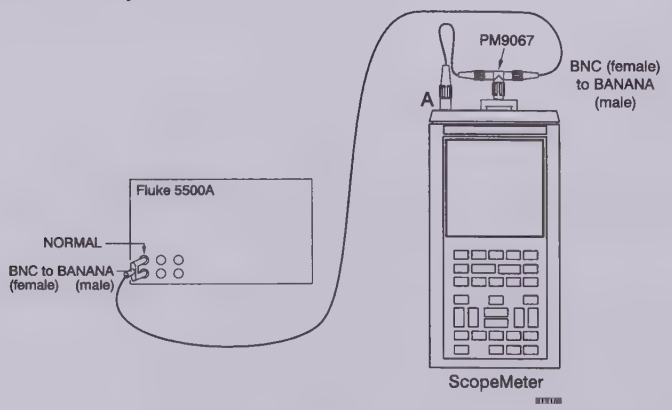


Purpose: calibrate the current ramp of the component tester.

Calibration equipment:

Fluke 5500A Multi-Product Calibrator, output NORMAL (SCOPE off).

Calibration setup:

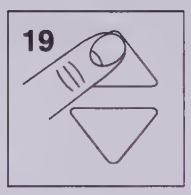


Procedure:

A - Connect a resistance of 100Ω between the banana jack inputs. Connect the INPUT A BNC signal input to the red banana jack input. Do not use a probe! Refer to the calibration setup.

B - Press the READY function key.

M19/20. 10:1 calibration for INPUT A (red) and INPUT B (grey) probes

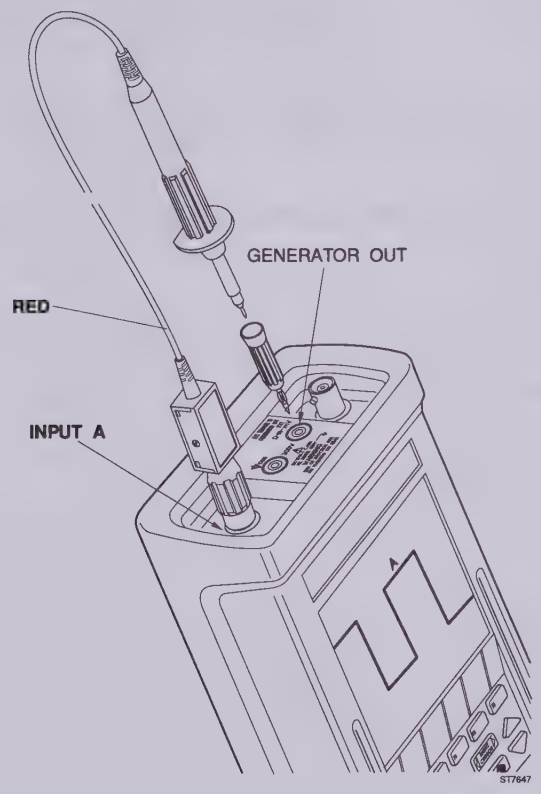


Purpose: determine the gain, using a 10:1 probe.

Calibration equipment:

Red scope probe (delivered with the ScopeMeter test tool)
Grey scope probe (delivered with the ScopeMeter test tool)
4 mm banana adapter (delivered with the ScopeMeter test tool)

Calibration setup:



IMPORTANT: Calibration steps M19 and M20 determine the internal calibration constants that compensate for probe characteristics. To achieve full accuracy (as listed in the specifications in chapter 2), calibrations M19 and M20 must be performed, using the probes that are normally to be used with the instrument.

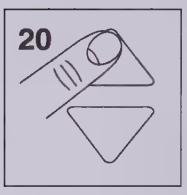
If the probes delivered with the ScopeMeter test tool are not available at the time of calibration, use other probes specifically designed for the ScopeMeter test tool. In this case you must notify the user that these calibrations have been performed, using different probes. To achieve full accuracy, the user must do a User Probe Calibration, using his own probes. This procedure is described in the Users Manual. You will loose the results of the User Probe Calibration when you do a MASTER RESET. (A MASTER RESET is done when the ScopeMeter test tool is turned on while the F5 function key is depressed. Two beeps are audible.)

Procedure:

A - Connect the red scope probe to the INPUT A BNC.

B - Connect the probe tip to the GENERATOR OUT red banana jack using the 4 mm banana adapter. Refer to the Calibration setup.

C - Press the READY function key.
After a few seconds the ScopeMeter test tool will display:
"Calibration has been completed successfully"
and will also beep once. Press F1 to clear the message. Now you can go to the next calibration step.

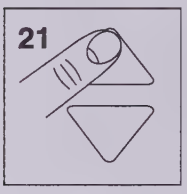


D - Connect the grey scope probe to the INPUT B BNC.

E - Connect the probe tip to the GENERATOR OUT red banana jack using the 4 mm banana adapter. Refer to the Calibration set-up.

F - Press the READY function key.
After a few seconds the ScopeMeter test tool will display:
"Calibration has been completed successfully"
and it will also beep once. Now you can go to the next calibration step.

M21/22. 1:1 probe calibration for INPUT A and INPUT B

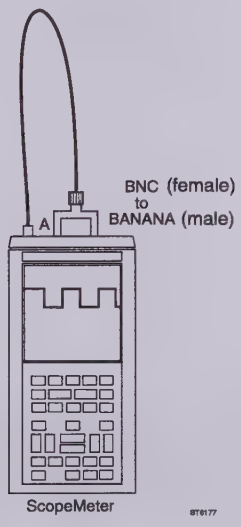


Purpose: determine the gain, using a 1:1 probe.

Calibration equipment:

none

Calibration set-up:



Procedure:

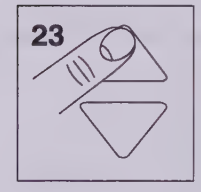
A - Connect the INPUT A BNC to the GENERATOR OUT red banana jack, by means of a BNC cable and a BNC (female)-to- banana(male) connector.

B - Press the READY function key.
After a few seconds the ScopeMeter test tool will display:
"Calibration has been completed successfully"
and will also beep once. Now you can go to the next calibration step.

C - Connect the INPUT B BNC to the GENERATOR OUT red banana jack, by means of a BNC cable and a BNC(female)-to-banana(male) connector.

D - Press the READY function key.
After a few seconds the ScopeMeter test tool will display:
"Calibration has been completed successfully"
and it will also beep once.

M23. Channel A, 1V range: gain calibration.



Purpose: calibration of the channel A gain in the 1V range.

Calibration equipment:

Fluke 5500A Multi-Product Calibrator, output NORMAL (SCOPE off).

Calibration setup:

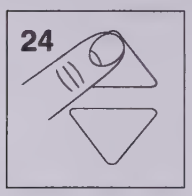
As for M4/5/6/7

Procedure:

A - Apply 1V DC to the INPUT A BNC.

B - Press the READY function key.

M24. Channel A, 100V range: gain calibration.



Purpose: calibration of the channel A gain in the 100V range.

Calibration equipment:
Fluke 5500A Multi-Product Calibrator, output NORMAL (SCOPE off).

Calibration setup:
As for M4/5/6/7

Procedure:

WARNING: After you performed M24 deactivate the Fluke 5500A with the STBY key before touching the cables!

A - Apply 100V DC to the INPUT A BNC.
B - Press the READY function key.
Calibration is now complete. You must store the calibration values now: see CAL STORE.

CAL STORE

To save the new calibration values, you must proceed as follows:
- press the METER softkey to leave the active CALIBRATION mode.
- press the CAL STORE softkey to store the new calibration values in flash ROM.

6 DISASSEMBLING THE SCOPEMETER TEST TOOL

6.1 GENERAL INFORMATION

Whenever the ScopeMeter test tool needs repair and/or Hardware SCOPE Calibration Adjustments, the instrument must be disassembled.

NOTE: For replacement of components refer to section 7.2; for Hardware SCOPE Calibration Adjustments refer to section 5.6.1.

This section provides the required disassembling procedures. Both printed circuit boards removed from the instrument must be adequately protected against damage, and all normal precautions regarding the use of tools must be observed. During the disassembly process, make a careful note of all disconnected leads so that they can be reconnected to their correct terminals when you reassemble the instrument.

WARNING: Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals may be live. To avoid electric shock, disconnect the instrument from all voltage sources and remove batteries before disassembling the instrument. If any adjustment, maintenance, or repair of the disassembled instrument under voltage is required, it shall be carried out only by qualified personnel using customary precautions against electric shock. Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources and batteries have been removed.

6.2 DISASSEMBLY PROCEDURES

The following sections describe the disassembly process of the ScopeMeter test tool in sequence (from fully assembled instrument to separate printed circuit boards and chassis parts). Start and end disassembly at the appropriate heading levels.

WARNING: To avoid electric shock, disconnect test leads, probes and power supply from any live source and from the ScopeMeter test tool itself.

6.2.1 Removing the battery pack

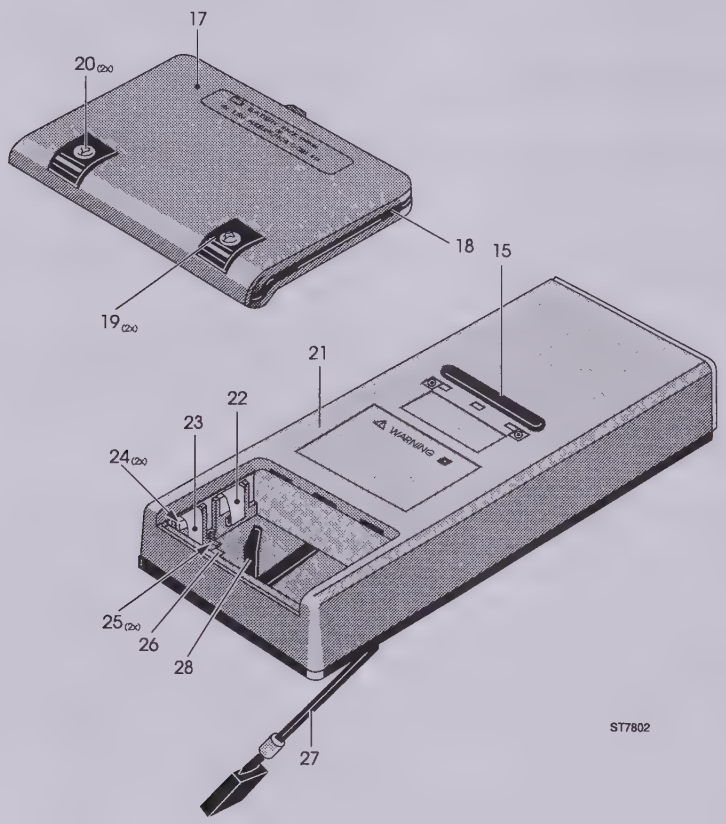


Figure 6.1 Removing the battery pack

1. The battery cover (item 17) is secured to the ScopeMeter test tool with two black M3 Torx screws (item 20). Use a Torx screwdriver to loosen the two screws (do not remove them) from the battery cover.
2. Lift the battery cover from the ScopeMeter test tool.
3. Pull the black battery pull strip (item 28) carefully to lift the battery pack.
4. Remove the battery pack.

6.2.2 Opening the ScopeMeter test tool

Referring to figure 6.2, use the following procedure to open the ScopeMeter test tool.

1. Loosen the two black M3 Torx screws (item 4) (do not remove them) from the front cover.
2. Lift the front cover assembly (item 3) from the ScopeMeter test tool.

NOTE: The gasket, between the front cover and the two case halves, is sealed to, and must remain with, the front cover. The front cover assembly lifts away from the top and bottom case halves easily. Do not damage the gasket or separate it from the front cover.
A correctly fitted gasket assures the sealing of the ScopeMeter test tool.

3. Remove the battery pack (see Section 6.2.1).

4. The bottom cover assembly is secured to the top cover with two M3 Torx screws (item 29) that are accessible in the battery compartment. Use a Torx screwdriver to remove the two screws.

5. Lift the bottom cover a little from the top cover and unfold the ScopeMeter test tool.

NOTE: Do not damage the black gaskets and keep them with the front cover and the lower case half. A correctly fitted gasket assures proper sealing of the ScopeMeter test tool.

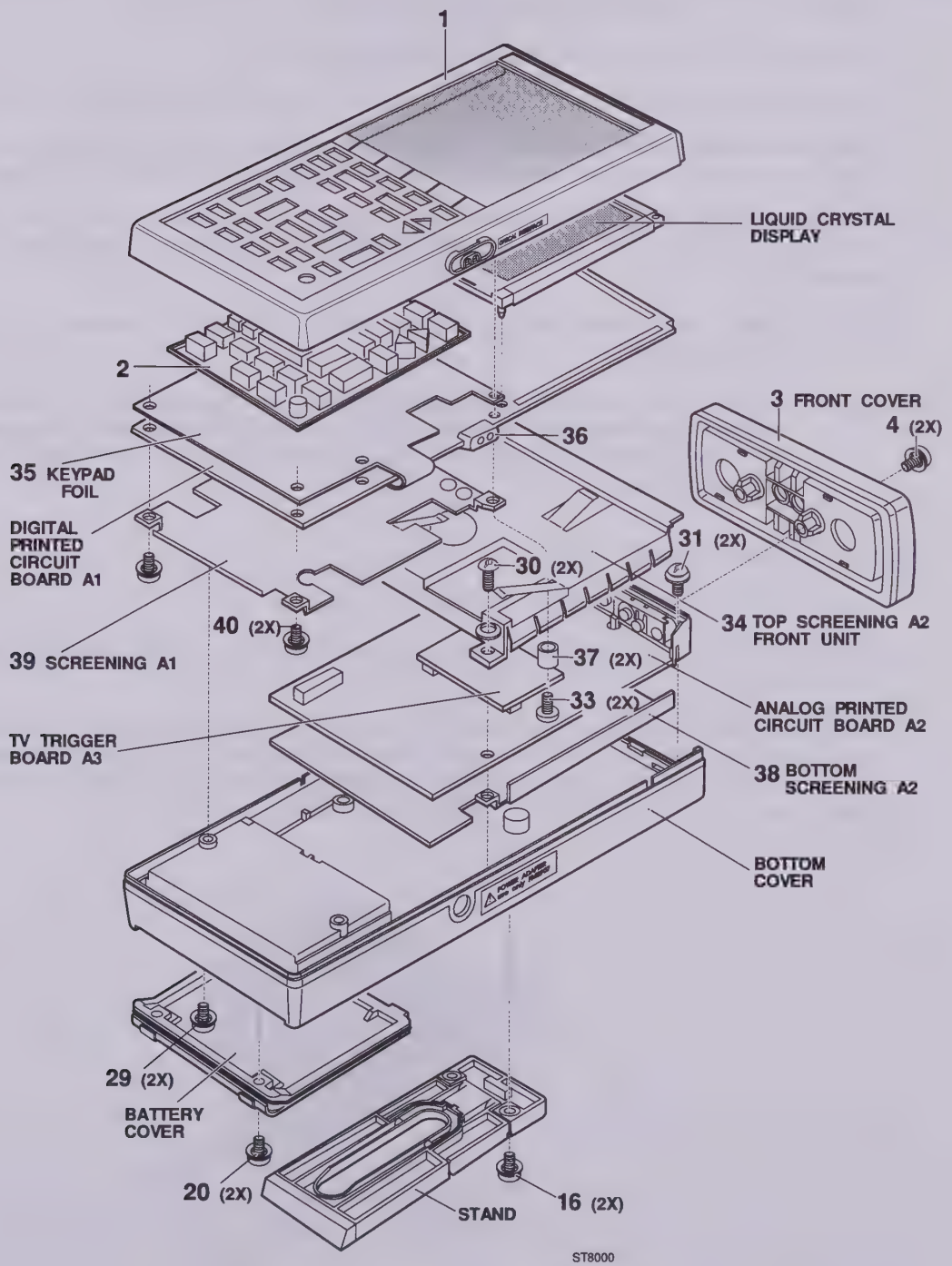


Figure 6.2 Opening the ScopeMeter test tool

6.2.3 Removing the analog A2 PCB, to enable Hardware SCOPE Calibration Adjustments

Referring to figure 6.2, use the following procedure to remove the analog A2 PCB.

1. First open the ScopeMeter test tool (see Section 6.2.2).
2. The analog A2 PCB and top screening are secured to the bottom cover with two M3 Torx screws (item 30). Use a Torx screwdriver to remove the screws.
3. Carefully lift the metal top screening, while pulling it backwards.
4. Pull the battery wiring plug (item 27, figure 6.1) out of the connector on the analog A2 PCB.
5. Use a Torx screwdriver to loosen the two black screws (item 13) (do not remove them) from the input unit assembly. Now the analog A2 PCB can be lifted out of the bottom cover assembly.
6. The bottom of the analog A2 PCB shows the components (potentiometers) used for hardware calibration adjustments. The Hardware SCOPE Calibration Adjustments are described in section 5.6.1.

NOTE: The digital A1 PCB is fixed to the top cover and must be connected to the analog A2 PCB by the 30-pole flat cable.

CAUTION: Damage may occur if you disconnect the flat cable between the two printed circuit boards within ten seconds after turning off the instrument. Damage may also occur when the Analog unit (A2) is powered when not connected to the Digital unit (A1).

6.2.4 Removing the digital A1 PCB

1. First open the ScopeMeter test tool (see Section 6.2.2).

NOTE: Note how the 30-pole flat cable is positioned in the connector: it must be replaced in exactly the same way

When the ScopeMeter test tool is opened, the blue marks on the flat cable must be visible. Carefully lift the upper part of the flat cable connector on the digital A1 PCB. This plastic clamp must be lifted at both sides simultaneously to unlock the flat cable. Now pull the flat cable out of the connector on the digital A1 PCB. Do not touch the flat cable ends!

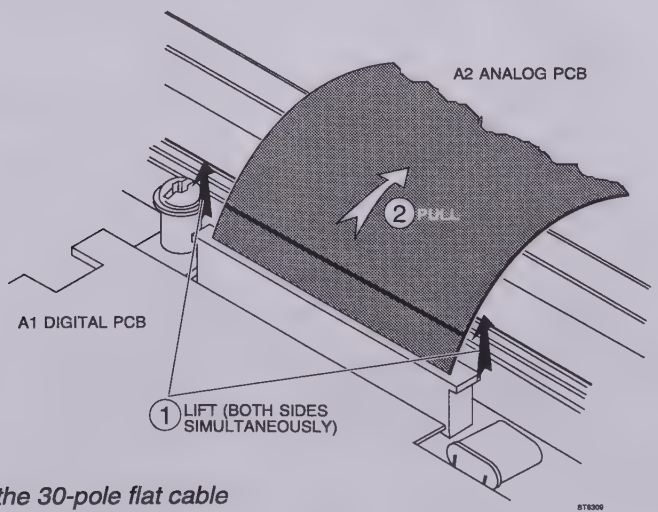


Figure 6.3 Removing the 30-pole flat cable

2. The digital A1 PCB is secured to the top cover with two M3 Torx screws (item 33). These screws contain small standoffs. Be sure to reinstall them when the ScopeMeter test tool is reassembled. Use a Torx screwdriver to remove the screws.

3. Remove the digital A1 PCB from of the top cover. Be careful not to damage the infrared LED and phototransistor of the optical interface.

NOTE: When reassembling the digital A1 PCB, make sure that the infrared LED and phototransistor are exactly aligned with the holes in the top cover.

7 CORRECTIVE MAINTENANCE

7.1 DIAGNOSTIC TESTING AND TROUBLESHOOTING

7.1.1 Introduction

The ScopeMeter test tool provides semimodular design to aid in troubleshooting. This section describes procedures needed to isolate a problem in a specific functional area. Finally, troubleshooting hints for each functional area are presented.

If the ScopeMeter test tool fails, first verify that you are operating it correctly by reviewing the operating instructions in the Users Manual.

WARNING: Opening the case may expose hazardous voltages. Always disconnect the instrument from all voltage sources and remove the batteries before opening the case. Remember that repairs or servicing should be performed by qualified personnel only.

7.1.2 Troubleshooting techniques

If a fault appears, the following test sequence can be used to help you to locate the defective component:

- Check to verify that the control settings of the test tool are correct. Consult the operating instructions in the Users Manual.
- Check the equipment to which the test tool is connected and check the interconnection cables.
- Verify that the test tool is properly calibrated (see section 4 Performance Verification Procedure). If it is not, refer to Chapter 5: "Calibration Adjustment Procedure".
- Locate the circuit(s) in which you suspect the fault: the symptom often suggests the faulty circuit. If the power supply is defective, the symptom may appear to be caused by several circuits.
- Check the circuit(s) in which you suspect the fault. Often it is possible to find faults such as cold or defective solder joints, intermittent or open interconnection plugs and wires or damaged components.

7.1.3 Performance Verification

The Performance Verification Procedure described in chapter 4 is a very quick way to check most of the test tool's specifications. It is based on the specifications listed in Chapter 2 of this Service Manual. If the test tool fails of any of the tests, Calibration Adjustments (see chapter 5) and/or repair (see chapter 7) is necessary.

7.1.4 Troubleshooting

7.1.4.1 Trouble shooting hints

OPENING THE SCOPEMETER TEST TOOL:
To troubleshoot the test tool, open it as described in subsection 6.2.2 "Opening the ScopeMeter test tool" of chapter 6 "DISASSEMBLING THE SCOPEMETER TEST TOOL".

TEST POINT AND COMPONENTS LOCATION:
Added with the A1 PCB layout figure 9.1 and the circuit diagrams figure 9.2a and 9.2b are location reference lists for fast location of the test points and the components.

CONNECTING THE GROUND (ZERO) LOGIC 0 REFERENCE:
While performing measurements, it is possible to use the metal shielding as zero reference. It is also possible to install the metal screws, as is described in section 5.6.1 "Hardware SCOPE Calibration Adjustments". You can use one of the screws as a zero reference: refer to figure 5.2. The A1 also provides a ground alligator clip connection in the lower left corner (∞).

LOGIC 1 LEVEL:
The logic one level is +5V.

7.1.5 Digital A1 PCB Troubleshooting

7.1.5.1 Powering the ScopeMeter test tool.

Power the test tool with the Power Adapter/Battery Charger PM8907.

7.1.5.2 Kernel Test

Start with the Kernel Test if the test tool does not function at all (no display, no beep at power on). With the Kernel Test the microprocessor and the transmitter/receiver circuit of the optical interface can be tested.

NOTE: If loading the FlashROM fails, it is possible to get a ScopeMeter test tool which is not functioning. For example: if the operating system is corrupted, it is not possible to operate the test tool normally. In this case you can reload the operating software as follows:
- *ground test point TP202, and turn on the test tool*
- *load the operating software into the FlashROMs. For this action you need special software: contact your nearest Fluke Service Center.*
- *release the ground from TP202 and perform a MASTER RESET (hold down the F5 key and turn the test tool on).*

Proceed as follows to start the kernel test:

1. Ground TP202 on the digital A1 PCB.

2. Power the test tool with the Power Adapter/Battery Charger PM8907.

3. Turn on the ScopeMeter test tool.

As TP202 (MASKN) is grounded, the test tool does not access the FlashROM software. Only the program in the microprocessor ROM (MASK program) is running.

4. Measure the signal on TP115 (AD15) with an oscilloscope. The oscilloscope must show a 140 kHz signal, see the figure below.

5. Connect the optical interface via the PM9080 cable to a PC (DOS), and send 10 characters X (capital) from the PC to ScopeMeter test tool. Check that the test tool receives the characters (TP340), and that it responds (TP350).

   Proceed as follows:

   - make a file X.X containing 10 characters X (capitals):

     type **COPY CON X.X**
     XXXXXXXXXX
     press **Ctrl Z**

   - set the parameters of used the PC communication port, e.g. COM1:

     type **MODE COM1: 1200 N 8 1**

   - send file X.X (= 10 times a X) to the ScopeMeter test tool:

     type **COPY X.X COM1**

     NOTE: you can make a batch file X.BAT to repeat the command COPY X.X COM1 continuously proceed as follows:

     Type **COPY CON X.BAT**
     COPY X.X COM1
     X.BAT
     Press **Ctrl Z**

     Type **X.BAT** to start
     Press **Ctrl Break** to stop.

   - measure on TP340 (RXD) and TP350 (TXD) with an oscilloscope to see that the test tool receives the characters X (TP340), and that it responds (TP350).
     On TP340 and TP350 +5V pulses must be measured.

Proceed as follows to stop the kernel test:

1. Switch off the test tool.

2. Remove the connection between TP202 and ground.

3. Perform a MASTER RESET when switching on again.

7.1.5.3 Test Point signals

The digital A1 PCB is provided with test points. In the A1 PCB diagrams, the test points are marked "TP...". On the A1 PCB the test points are located in a white square, provided with the test points number and name. The test points can be used to check the correct functioning of the digital A1 PCB.

All measurements are made in the default MASTER RESET condition (start the measurements in the ScopeMeter test tool after a MASTER RESET).

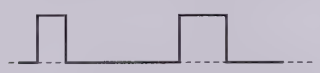
A MASTER RESET is performed as follows:

1. Remove all signals from the ScopeMeter test tool.
2. Turn off the ScopeMeter test tool.
3. Hold down the F5 key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The test tool is automatically set to the METER mode.

Use another oscilloscope with high input impedance and 10:1 probe to measure the signals on the test points. See table 7.1. Use the alligator-clip point (two joined metallized holes in the digital A1 PCB, sector D4).

Table 7.1. Overview on Test Points on the digital A1 PCB

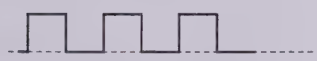
Logic 0 = 0V ; Logic 1 = +5V

TP	Name	Signal	Freq/Per	Description
005	+5V	+5.1V ... +5.3V	DC	+5V supply. If too low, check A2 revision level. Upgrade to level 17 if it is 16 or lower
050	ADVN		100 ns	Adress valid signal
052	WRIN		varying	Write signal, 80 ns pulses
053	RDIN		varying	Read signal, 80 ns pulses
100 . . . 115	AD0 . . . AD15		varying	Address/data lines AD0 AD15
150	PS0		varying	Page select 0; 0.5 ... 1.5 µs pulses
151	PS1	0V	DC	Page select 1
152	PS2		varying	Page select 2; 0.5 ... 1.5 µs pulses
170	MS0		varying	Address line for standard RAM and ROM; minimum pulse width 0.15 µs

TP	Name	Signal	Freq/Per	Description
171	MS1		varying	Address line for standard RAM and ROM
172	MS2		varying	Address line for standard ROM
173	MS3		varying	Address line for standard ROM D1220; shows pulses if D1220 is installed
174	SCEN		varying	Chip enable signal for external RAM
175	FCEN		varying	Chip enable signal for standard ROM
176	BCEN	-	-	not used
177	XCEN		varying	Chip enable signal for standard RAM
180 . . . 194	A00 . . . A14		varying	Address lines A00 A14
201	µPCLK		12.5 MHz	Microprocessor clock
202	MASKN	+5V	DC	Mask not input. If made low, only µP-ROM program runs (FlashROM software does not run)
203	WEN		varying	Write signal for D-ASIC and EXTERNAL RAM
204	REN		1.25 MHz	Read signal for D-ASIC and EXTERNAL RAM
208	+5VUP	+5V	DC	µP supply
210	RESETN	+5V	DC	Reset line, is kept low after power on until +5V supply is at 4.7V
215	+5VMA	+5V	DC	M-ASIC supply
225	+5VFL	+5V	DC	FlashROM supply

TP	Name	Signal	Freq/Per	Description
230	READY		varying	µP ready input to lengthen external memory cycles; low pulses ≥ 0.15 µs
231	µRESETN	+5V	DC	Microprocessor reset; low during reset
232	INST		varying	ROM instruction fetch; low pulses ≥ 0.15 µs
235	+5VDA	+5V	DC	Display control circuit supply
300	-VBAT	-4.8V	DC	Nominal battery voltage (without mains adapter)
		-4.3V ± 0.15V		"battery low" warning
		-3.9V ± 0.15V		ScopeMeter test tool switches off
301	BAT-LEVEL	+3.2V	DC	At nominal battery voltage (without mains adapter)
		+2.9V ± 0.1V		"battery low" warning
		+2.65V 0.1V		ScopeMeter test tool switches off
310	-		4 ms	RAM POWER oscillator signal at power off; +0.8V DC at power on
311	+VRAM	+4V	DC	RAM POWER output at power off
		+5V	DC	RAM POWER output at power on
330	VPP	+12V	DC	FlashROM programming voltage, to be supplied in battery compartment
340	RXD	+5V or 0V	DC	Optical interface receiver H1340 dark: +5V, light: 0V
350	TXD	+5V or pulses	-	Optical interface transmitter Not sending: +5V, sending: pulses
401	FRAME		15 ms	Display column-scan pulse, X1-X80 (display refresh)

TP	Name	Signal	Freq/Per	Description
402	FR1		15 ms	Display column-scan pulse, X81-X160
403	FR2		15 ms	Display column-scan pulse, X161-X240
405	+5VDP	+5V	DC	Display control supply
406	CAR		60 µs	Enables row drivers D1404 and D1405 if data in D1406 is complete
420	V1	-0.3V ... +4.6V	DC	Contrast light ... dark
421	V6	-2V ... +2.7V	DC	Contrast light ... dark
422	V3	-3.7V ... +0.8V	DC	Contrast light ... dark
423	V4	-22V	DC	At room temperature; changes with temperature
424	V5	-24V	DC	See 423
425	V2	-26V	DC	See 423
430	-	+0.3V ... +5V	DC	Contrast control signal, light ... dark
431	LCDPWR	+5V	DC	LCD ON/OFF (+5V/0V), low during reset
432	-30V	-30V	DC	LCD-SUPPLY supply voltage
440	BLGND	-8V	DC	Pin 3 N1440 (backlight ON); ≈ 150 mV ripple
441	-	-	-	Not used
442	BACKLIGHT		1 kHz	PIN 4 N1440 (backlight ON)
446	DTCLA		500 kHz	Data clock for LCD row drivers
450	LCD0		varying	LCD row driver data input
451	LCD1		varying	LCD row driver data input

TP	Name	Signal	Freq/Per	Description
452	LCD2		varying	LCD row driver data input
453	LCD3		varying	LCD row driver data input
454	M		35Hz	LCD backplane modulation signal
455	LINECL		16 kHz	LCD column clock; pulse length 2 µs
456	DATACL		0.8 ... 1.2 µs	LCD row driver data clock
460	LCD0A		varying	LCD row driver data input
461	LCD1A		varying	LCD row driver data input
462	LCD2A		varying	LCD row driver data input
463	LCD3A		varying	LCD row driver data input
464	M1		600Hz	Randomized backplane modulation signal
501	ON	+5V	DC	At power on;
		-5.5V	DC	At power off, if mains adapter voltage is present and battery installed
		-5V	DC	At power off, battery supply only
		-8V	DC	At power off, if mains adapter voltage is present, and battery removed
502	NOT-ON	0V	DC	At power on
		+3V ... 4V	DC	At power off, if mains adapter voltage is present
		+3V ... 4V	DC	At power off, battery supply only
503	ON-OFF		30 ms	Power off pulse from µP at switching off
504	ON-RESET	+5V	DC	At power on
		+3V ... 4V	DC	At power off
		0V	DC	During pressing the ON/OFF key
505	ON-KEY	0	DC	At power off and power on
		-5 ... -5.5	DC	During pressing the ON/OFF key

7.1.6 Analog A2 PCB Troubleshooting

7.1.6.1 Test point signals

The analog A2 PCB is provided with test points, marked: "TP" See figure 10.4: A2 PCB layout (wired components side). These can be used to check correct functioning of the PCB.

All measurements are made in the default MASTER RESET condition (start the measurements after a **MASTER RESET**).

A MASTER RESET is performed as follows:
1. Remove all signals from the ScopeMeter test tool.
2. Power the test tool with the Power Adapter/Battery charger PM8907.
3. Turn off the ScopeMeter test tool.
4. Hold down the F5 key and press the ON/OFF key simultaneously. Two beeps are audible, and all volatile memories (RAM with battery backup) are reset. The test tool is automatically set to the meter mode.

NOTE: For the measurements on Test Points 101...529 and 901...921 apply a 1 Volt, 10 kHz square wave signal to the INPUT A and INPUT B BNC (INPUT B not for model 91). Press the SCOPE METER key and then the F1 key to go to SCOPE mode and press AUTOSET to get a stable picture on the LCD.

NOTE: For the measurements on Test Points 700...806 first switch on the ScopeMeter test tool using a MASTER RESET. Then press USER OPTIONS, F5 (PROBES MENU), select CALIBRATE PROBE ON A (▽ key), and press F5 to select. Now the generator provides a 1.95 kHz square wave.

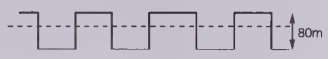
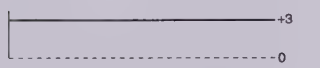
NOTE: You can remove PCB A3 to reach all Test Points.

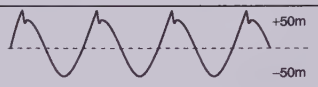
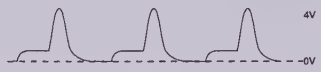
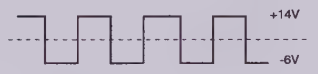
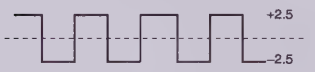
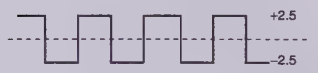
Use another oscilloscope with high input impedance and 10:1 probe to measure the signals on the test points. See table 7.2:

Table 7.2 Overview signals on Test Points (TP) on analog A2 PCB

Logic 0=0V, Logic 1=+5V

TP	Name	Scope	Freq.	Data	Description
101			0		Base V2112
102			0		Output D2101
103			10 kHz		Output N2101 (-2.2V DC)
104			10 kHz		Collector V2105
106			0		Base V2104
107	ATTB--A		10 kHz		Collector V2111, Moves at MOVE ⇳

TP	Name	Scope	Freq.	Data	Description
108			0		TP for OFFSET DAC
109	POS-CHB		0		POS-CHB, moves at MOVE ⇳ (inverse)
201			0		Base V2212
202	mV-in from A2d		0		Output D2201
203			10 kHz		Output N2201, V_{DC} = -2V
204			10 kHz		Collector V2205
206			0		Base V2204
207	ATTA--A		10 kHz		Collector V2211, moves at MOVE ⇳
208			0		TP for offset DAC, ≈0V
209	POS-CHA		0		POS-CHA moves at MOVE ⇳ (inverse)
331			0		VREF D2301
332			LF: sq. 3 Hz HF: sq. 10 KHz		SGN-in N2301
501			70 kHz		Collector V2517, V_{DC} = -7.7V
502			45 kHz		Base V2517, V_{DC} = -7V
503			45 kHz		Base V2503
504			45 kHz		Sense Resistors, Pos. side V_{DC} = -7.7V
506			45 kHz		Sense Resistors, Neg. side V_{DC} = -7.7V
507	+Vref		0		+Vref
508	-Vref		0		-Vref
509			0		Output N2501
511			0		TP for FEEDBACK AMPLIFIER

TP	Name	Scope	Freq.	Data	Description
521			250 kHz		PSG-Input Z2501
522			100 kHz		Oscillator N2503
523			0		INV N2503
524			100 kHz		Collector V2526
526			100 kHz	Source	V2532
527			100 kHz	Source	V2537, V_{DC} ≈-0.2V
528			100 kHz	Source	V2538, V_{DC} ≈ -50mV
529			0		CLN N2503
700 *			1.95 kHz		Relay contact K2750a/K2751b
701 *			1.95 kHz		Anode Zener V2752
702 *			0		Output D2850
704			0		Collector V2761, at Ω, input shorted
706			-2V		Kathode zener V2763, at Ω, input shorted
801 *					Output D2850
802 *			0		Emitter V2852
803 *			0		Non-inverting input N2850a
804 *			1.95 kHz		Output N2850
805 *			0		Non-inverting input N2850b
806 *			0		TP for CURRENT SOURCE
901			0		Output 1&2 D2901

* GENERATE ON, SEE NOTE AT PAGE 7-9!

TP	Name	Scope	Freq.	Data	Description
902			0		Output 3&4 D2901
903			0		Output 5&6 D2901
904			0		Output 7&8 D2901
906			0		Output 1&2 D2902
907			0		Output 3&4 D2902
908			0		Output 5&6 D2902
909			0		Output 7&8 D2902
911			0		Output 1&2 D2903
912			0		Output 3&4 D2903
914			0		Output 7&8 D2903
916	Sgnd8a		-50mV		Sgnd8a D2904
917	Ex/Ey		0		Ex/Ey D2906
918	Sgnd8b		0		Sgnd8b D2907
919	Sr4b		0		Sr4b D2908
921	D-POSCHB		0		D-POSCHB D2909

7.2 MAINTENANCE OF THE PRIMARY CIRCUIT (PM8907/...)

The ScopeMeter test tool itself has no primary (mains) power supply.
The instrument is powered with a separate **Power adapter/battery charger PM8907/...**, in which the primary power supply is located. The PM8907/... is non-repairable. It can be ordered at your nearest Fluke Service Center.

Table 7.1 Power adapter/battery charger survey.

Typenumber	Description
PM8907/801	Universal Europe 220V, 50 Hz
PM8907/803	North American UL, CSA, 110V, 60 Hz
PM8907/804	United Kingdom 240V, 50 Hz
PM8907/808	Universal 115V / 230V
PM8907/806	Japan

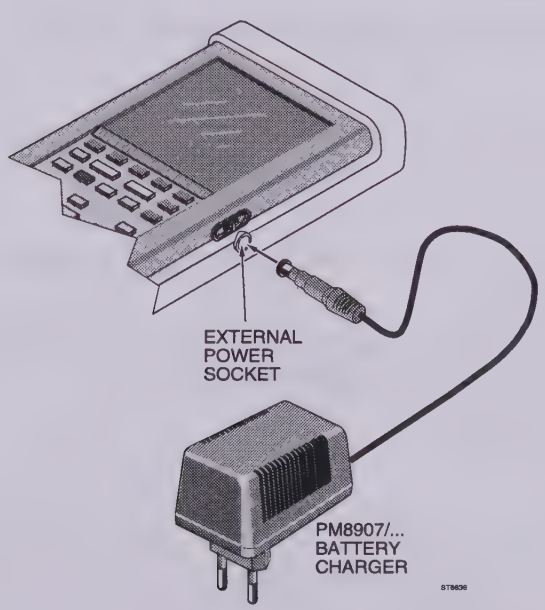


Figure 7.1 ScopeMeter test tool Power Adapter/battery Charger PM8907/....

7.3 REPLACEMENTS

7.3.1 Standard parts

Electrical and mechanical parts replacements can be obtained through your local FLUKE organization or representative. However, many generic electronic components can be obtained from other sources. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE: Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade the instrument's performance.

7.3.2 Special parts

In addition to the standard electronic components, some special components are used:

- Components, custom manufactured or selected by FLUKE to meet specific performance requirements.

- Components that are important for the safety of personnel.

NOTE: Both type of components may only be replaced by components obtained through your local FLUKE organization or representative.

7.3.3 Transistors and integrated circuits

Some notes on handling these components:

- Do not replace or swap semiconductor devices unnecessarily, because the change may affect the calibration of the instrument.

- When a device has been replaced, check the circuit that may be affected for proper operation. See also the Performance Verification Procedure in chapter 4.

7.3.4 Static-sensitive components

In the ScopeMeter test tool the black/yellow "static-sensitive components" symbol is present (see also figure 7.2). This means that this instrument contains electrical components that can be damaged by electrostatical discharge. Although all MOS integrated circuits incorporate protection against electrostatic discharge, they nevertheless can be damaged by accidental overvoltages.

Figure 7.2 Static-sensitive symbol (black/yellow)

It is also possible that a delayed failure or "winding" effect may occur. When this happens, the component will fail anywhere between two hours to six months later.

When storing and handling static-sensitive components, the normal precautions for these devices are recommended. Handling and servicing static-sensitive assemblies and components should be done only at a static free workstation by qualified personnel.

CAUTION: Testing, handling, and mounting call for special attention. Personnel handling static-sensitive devices should normally be connected to ground via a high-ohmic resistor.

7.3.5 Replacement of parts

7.3.5.1 Replacing parts in the battery compartment

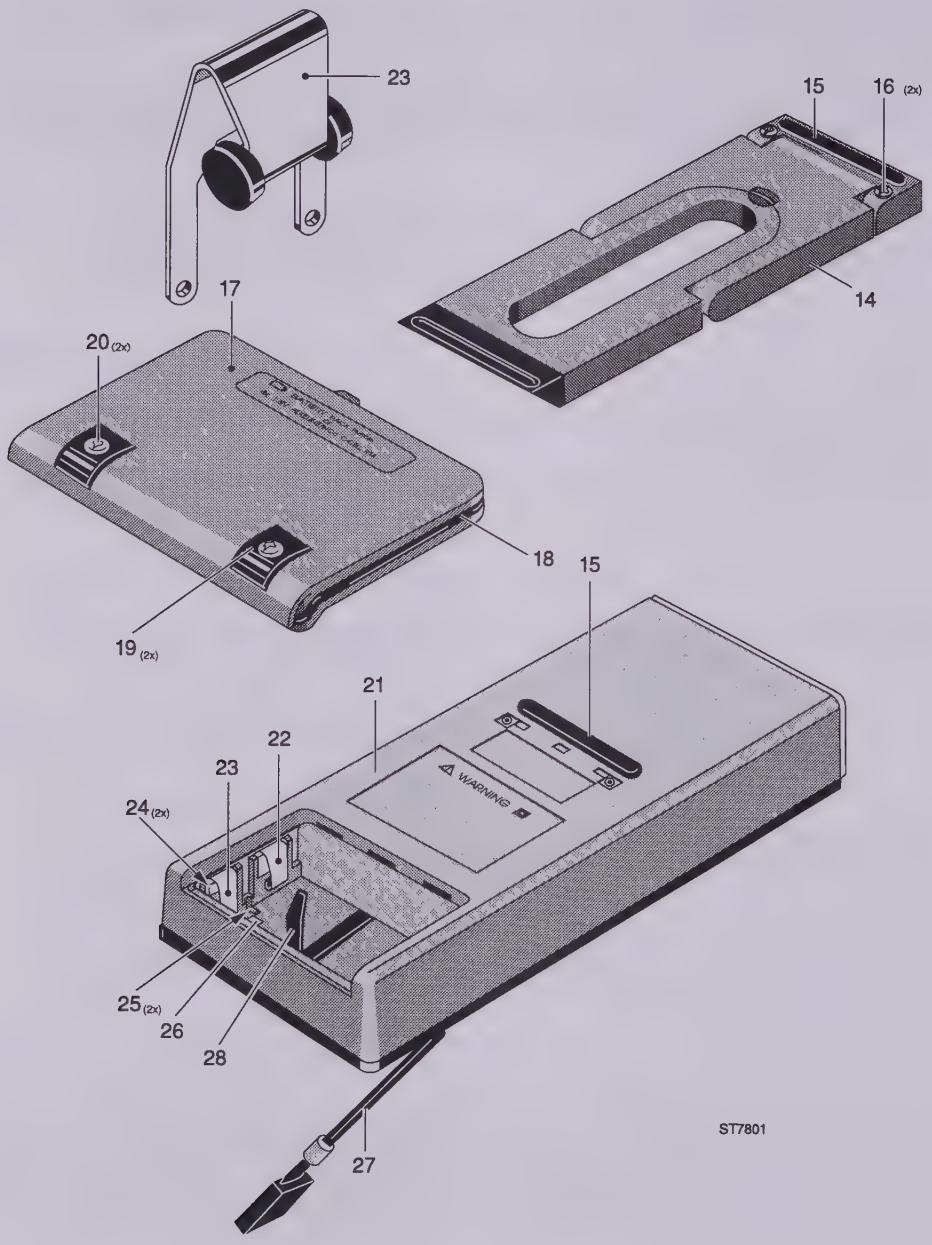


Figure 7.3 Replacing parts in battery compartment

Referring to figure 7.3, use the following procedure for replacements in the battery compartment.

Battery cover assembly replacement

1. The battery cover (item 17) is secured to the ScopeMeter test tool with two black M3 Torx screws (item 20). Use a Torx screwdriver to loosen the two screws (do not remove them) from the battery cover.

2. Lift the battery cover from the ScopeMeter test tool.
3. Reinstall the new battery cover.

Battery-cover Gasket replacement

1. Remove the battery cover (item 17).
2. Use a pair of tweezers to pull the elastic gasket (item 18) from the battery cover.
3. Mount the new elastic gasket on the battery cover.

NOTE: Take care that the gasket is not damaged. A correctly fitted gasket assures the sealing of the ScopeMeter test tool.

Battery cover Torx screws and Feet replacement

1. Remove the battery cover.
2. The black M3 Torx screws are of a captured type (item 20). Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.

3. Pull the two rubber feet (item 19) from the battery cover.
4. Push the new rubber feet onto the battery cover.
5. Reinstall the (new) black M3 Torx screws into the battery cover.

7.3.5.2 Replacing parts on front cover

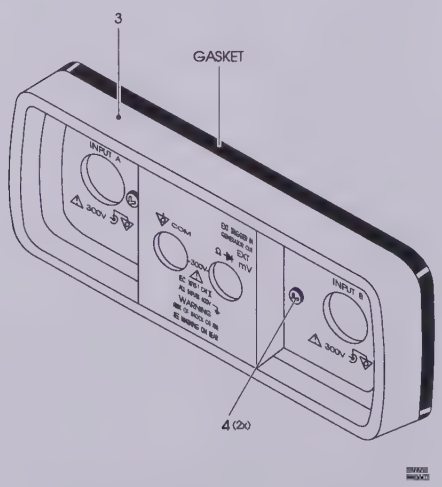


Figure 7.4 Replacing parts on front cover

Referring to figure 7.4, use the following procedure for replacements on the front cover.

Front cover assembly replacement

1. The front cover is secured to the ScopeMeter test tool with two black M3 Torx screws (item 4). Use a Torx screwdriver to loosen the two screws (do not remove them) from the front cover.

2. Lift the front cover assembly (item 3) from the ScopeMeter test tool.

NOTE: The gasket between the front cover and the two case halves is sealed to, and must remain with, the front cover. The front cover lifts away easily. Do not damage the gasket and do not separate the front cover from the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter test tool .

3. Reinstall the new front cover.

Front cover Torx screw replacement

1. Remove the front cover.

2. The two black M3 Torx screws (item 4) are captured type screws. Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.

3. Reinstall the new Torx screws into the front cover.

7.3.5.3 Replacing parts on bottom cover

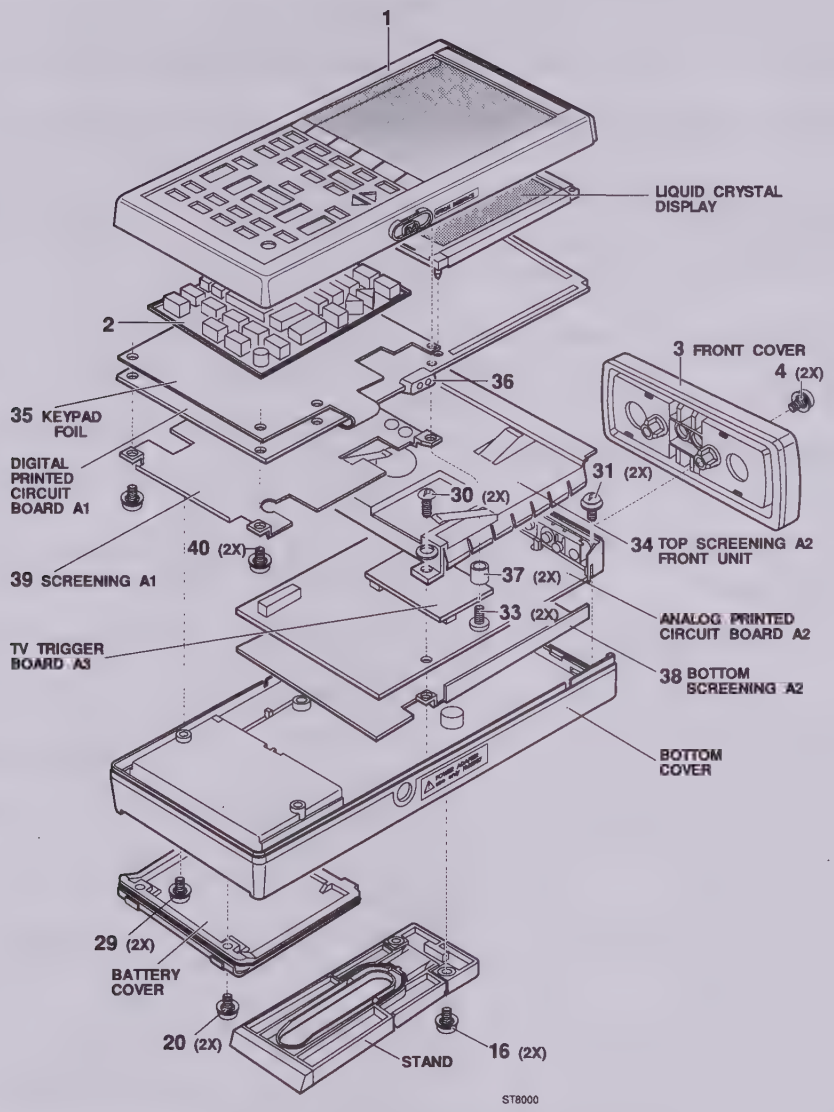


Figure 7.5 Bottom cover replacements

Referring to figure 7.5, use the following procedure for replacements in the bottom cover.

Bottom cover assembly replacements

1. First remove the battery cover assembly (see Section 7.3.5.1.)
2. The bottom cover is secured to the top cover by two M3 Torx screws (item 29) that are accessible in the battery compartment. Use a Torx screwdriver to remove the two screws.
3. Lift the bottom cover a little from the top cover and unfold the ScopeMeter test tool.

NOTE: A flat cable is used for interconnection between the bottom cover with the analog A2 PCB and the digital A1 PCB. To remove the flat cable, refer to Section 6.2.4. The gasket between the two case halves is sealed to, and must remain with, the lower case half. The upper case half lifts away easily. Do not damage the gasket and do not separate the lower case half from the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter test tool.

4. The analog A2 PCB and top screening are secured to the bottom cover by two M3 Torx screws (item 30). Use a Torx screwdriver to remove the two screws.

5. Carefully lift the metal top screening, while pulling it backwards.

6. Pull the battery wiring plug (item 27) out of the connector on the analog A2 PCB.

7. Use a Torx screwdriver to loosen the two black screws (item 13). Do not remove them from the input unit assembly. Now the analog A2 PCB can be lifted out of the bottom cover assembly.

8. Fold the analog A2 PCB back on the digital A1 PCB in the top cover.

9. Lift the bottom cover screening out of the bottom cover assembly.

10. Reinstall the new bottom cover assembly.

Battery wiring assembly replacement

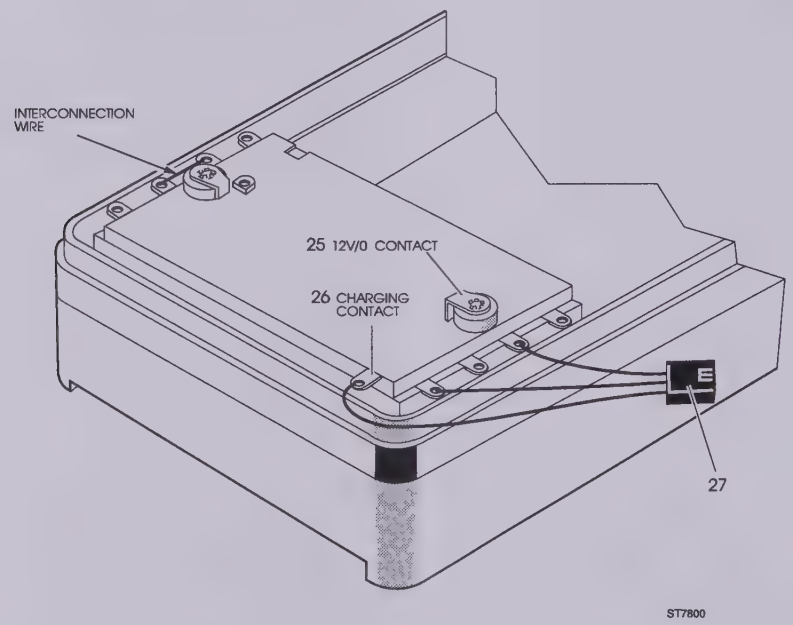


Figure 7.6 Wiring assembly replacement

Referring to figures 7.3 and 7.6, use the following procedure for replacing the battery wiring and battery contacts.

1. First remove the bottom cover assembly.

2. Unsolder the battery wiring assembly (item 27) from the battery compartment.

3. Reinstall the new battery wiring assembly.

Battery contacts replacement

1. First remove the bottom cover assembly.

2. Remove the battery wiring assembly.

3. Unsolder the small battery contact interconnection wire (see figure 7.6).

4. Bend the solder tags of the battery contacts (figure 7.3, item 23) in the bottom cover in such way that the contacts can be pulled out of the battery compartment.

5. Pull the battery contacts (figure 7.3, items 22 and 23) and the black buffers (figure 7.3, item 24) out of the battery compartment with a pair of tweezers.

NOTE: The extra black plastic buffers in two battery contacts (see figure 7.3, item 23) prevent erroneous charging of the battery. Mount these battery contacts in the correct position!

6. Reinstall the new battery contacts.

Battery charging contact and +12V/0 contact replacement

1. First remove the bottom cover assembly.

2. Remove the battery wiring assembly.

3. Bend the solder lugs of the contacts (figure 7.3, items 25 and 26) in the bottom cover so that the contacts can be pulled from the battery compartment.

4. Pull the contacts from the battery compartment.

5. Reinstall the new charging contact and/or the new +12V/0 contacts.

7.3.5.4 Stand replacement

Referring to figure 7.3, use the following procedure for stand replacement.

Stand assembly replacement

1. The stand is secured to the ScopeMeter test tool with two black M3 Torx screws (figure 7.3, item 16). Use a Torx screwdriver to loosen the two screws.

2. Lift the stand from the ScopeMeter test tool.

3. Reinstall the new stand.

Stand Torx screw replacement

1. Remove the stand assembly (figure 7.3, item 14).

2. The black M3 Torx screws are of a captured type (item 16).Remove screws by unscrewing them with a Torx screwdriver. Add a little pressure with another small screwdriver at the back of the screw.

NOTE: Do not force the screws by pressing them in or out. The screw action is vital for the captured screws.

3. Reinstall the new Torx screws.

7.3.5.5 30-pole flat cable replacement

Refer to Section 6.2.4. of this Service Manual for instructions on how to replace the 30-pole flat cable.

7.3.5.6 Input unit assembly replacement

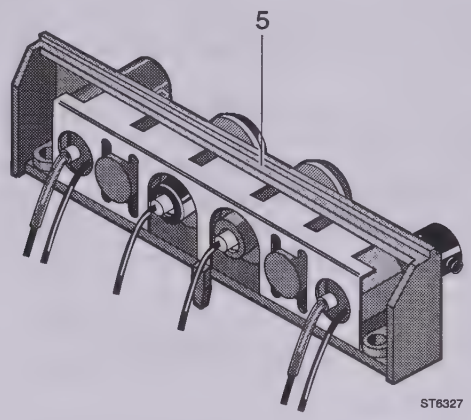


Figure 7.7 Input unit assembly

Referring to figure 7.7, use the following procedure for input unit assembly replacement.

1. Remove the front cover assembly.
2. Disassemble the bottom cover assembly.
3. Remove the 30-pole flat cable.
4. Unsolder the wiring (6x) of the input terminals from the analog A2 PCB.
5. The input unit assembly is clamped onto the analog A2 PCB. Loosen these clamps and pull the input unit assembly from the analog A2 PCB.

NOTE: The white gaskets on the input terminals (4x) are sealed to, and must remain with the input unit assembly. Do not damage the gaskets and do not separate them from the input unit assembly. Correctly fitted gaskets assure the sealing of the ScopeMeter test tool.

6. Reinstall the front unit assembly.

7.3.5.7 Top cover assembly replacement

Referring to figure 7.5, use the following procedure for top cover assembly replacement.

1. Remove the bottom cover assembly.
2. Remove the 30-pole flat cable.
3. The digital A1 PCB is secured to the top cover with two M3 Torx screws (item 33). These screws contain standoffs. Be sure to put them on the right place again. Use a Torx screwdriver to remove the screws.
4. Lift the digital A1 PCB out of the top cover. Be careful not to damage the infrared LED and phototransistor of the optical interface.

NOTE: The gasket between the two Optical RS-232-C Interface LEDs on the digital A1 PCB and front cover must remain with the LEDs. The top cover lifts away easily. Do not damage the gasket. A correctly fitted gasket assures the sealing of the ScopeMeter test tool.

5. Lift the keypad from the top cover (item 2).

6. Reinstall the new top cover (item 1).

7.3.5.8 Keypad replacement

1. Remove the bottom cover assembly.
2. Remove the 30-pole flat cable.
3. Disassemble the top cover assembly.
4. Lift the keypad from the top cover (item 2, fig. 7.5).
5. Reinstall the new keypad.

7.3.5.9 Liquid crystal display (LCD), contact strips and backlight foil replacement

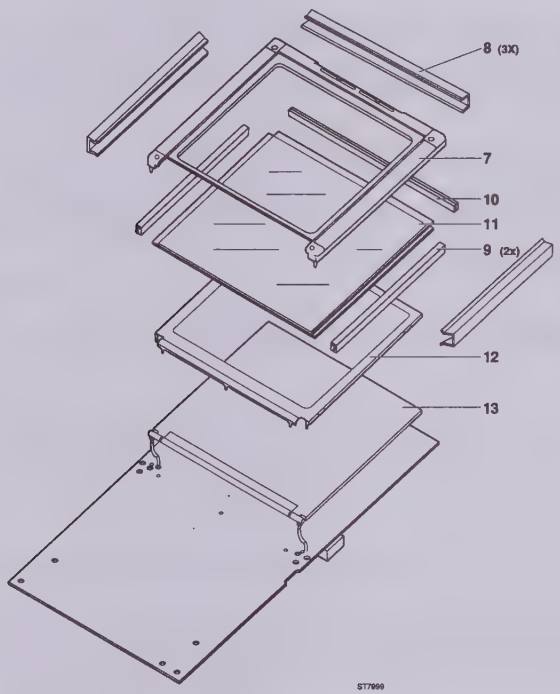


Figure 7.8 LCD replacement

Referring to figure 7.8, use the following procedure for LCD replacement.

1. Remove the bottom cover assembly.
2. Remove the 30-pole flat cable.
3. Disassemble the top cover assembly.

NOTE: Oils or dirt from the hands are ennemies of the LCD contact strips used in the LCD assembly. Whenever handling these strips, it is advised that tweezers be used so as not to contaminate them. Care should also be taken when handling the front panel lens or LCD glass. Dirt or finger prints on these parts will be visible to the user and may impair the readability of the display.

4. Pull the three metal clamps from the display (item 8).

5. Lift the LCD complete in its frame from the digital A1 PCB.
6. Push the LCD including the LCD contact strips out of the display frame.
7. Lift the top "I" LCD contact strip (item 10) from the display.
8. Pull the left and right "L" LCD contact strips (item 9) from the display.
9. The backlight foil (item 12) is glued to the reflective LCD. The backlight foil has two contact legs that make contact with two large rectangle spots on the digital A1 PCB.
10. Pull the backlight foil from the display.
11. Reinstall the LCD rubber filling part (item 13) and the back light foil.
12. Reinstall the two "L" LCD contact strips.
13. Reinstall the display with "L" LCD contact strips in the display frame.
14. Reinstall the "I" LCD contact strips on the display.
15. Reinstall the frame with the display assembly on the digital A1 PCB.
16. Reinstall the three metal clamps.
17. Reinstall the digital A1 PCB and top cover.

7.4 SOLDERING TECHNIQUES

7.4.1 General soldering techniques

Method:

- Carefully unsolder the soldering leads of the semiconductor one after the other.
- Remove all superfluous soldering material. Use desoldering wick, ordering code: 4822 321 40042.
- Verify that the leads of the replacement part are clean and have pre-tinned leads.
- Place the replacement semiconductor exactly in the same position, and solder each lead to the relevant printed circuit padon the PCB.

NOTE: The maximum permissible soldering time is 10 seconds during which the temperature of the leads must not exceed 250 °C. The use of solder with a low melting point is recommended. Take care not to damage the plastic encapsulation of the semiconductor (softening point of the plastic is 150 °C).

CAUTION: When you are soldering inside the instrument it is essential to use a low voltage soldering iron, the tip of which must be connected to the ground of the ScopeMeter test tool.

A suitable soldering iron is:

- Mini soldering iron station, WECP-COD3 (regulated transformer) and Weller LR-20 (soldering iron).

Ordinary 60/40 tin/lead solder with flux core and a 35W to 40W pencil- type soldering iron can be used to do most of the soldering. If a higher wattage soldering iron is used on the circuit PCB, excessive heat may cause the circuit wiring to separate from the PCB base material.

7.4.2 Soldering micro-miniature semiconductors

Because of the small dimensions of these SOT semiconductors and the lack of space between the components on the PCB, it is necessary to use a miniature soldering iron with a pinpoint tip (max. diameter 1 mm.) to solder a SOT onto a PCB.

Suitable soldering tools are:

- Mini soldering iron station, WECP-COD3 (regulated transformer) and Weller MLR-20 (mini soldering iron).
- A hot-air solder tool: Leister Hot-Jet

Next, the following materials are recommended:

- Soldering tin, diameter 0.8 mm., SnPb 60/40 with a Resin Mildly Activated (RMA) flux. Ordering code: 4822 390 80133.
- Desolder braided wire. Ordering code 4822 321 40042.
- Solder paste 26.
- Non-corrosive and Resin Mildly Activated (RMA) flux-Colophony. Ordering code: 4822 390 50025.

Refer to the **Support Bulletin OSC 296 (ordering code 4822 872 08407)** for a complete discussion of the soldering techniques for SMD's.

7.5 SPECIAL TOOLS

7.5.1 Extender flat cable

For diagnostic testing and troubleshooting, a 30-pole 50 cm extender flat cable can be used. Using this extender flat cable makes it easier to separate the two units A1 and A2 without breaking the interconnection.

The ordering code for the extender flat cable is: 5322 321 61369.

7.6 RECALIBRATION AFTER REPAIR

After any electrical component has been replaced the performance of that particular circuit should be checked, as well as the performance of other closely-related circuits. If necessary a recalibration must be performed. Since the power supply influences all circuits, the performance of the entire instrument should be verified if work has been done in the power supply or if the transformer has been replaced. If necessary a recalibration must be done. If parts of the attenuator circuits and/or the Analog ASIC have been replaced, it might be necessary to do Hardware SCOPE Calibration Adjustments. Refer to section 5.6.1 of this Service Manual.

7.7 INSTRUMENT REPACKING

If the ScopeMeter test tool is to be reshipped to a Service Centre for service or repair, attach a tag showing the full address and the name of the individual at the users firm that can be contacted.

The Service Centre needs the complete ScopeMeter test tool, **including the RED and the GREY scope probe**, its serial number, and a complete description of the problem and the work that is to be done. If the original container is not available, repack the instrument so that no damage occurs during transport.

8 LIST OF REPLACEABLE PARTS

Assembly name	Figure/page	Table/page
ScopeMeter test tool final assembly	8.1 8-3	8.1 8-2
Front cover assembly	8.2 8-5	8.2 8-4
Input unit assembly	8.2 8-5	8.2 8-4
Display assembly	8.2 8-5	8.2 8-4
Battery contact assembly	8.3 8-7	8.3 8-6
Stand assembly	8.3 8-7	8.3 8-6
Battery cover assembly	8.3 8-7	8.3 8-6
Digital A1 PCB assembly	8.4 8-8	8.4 8-8
Analog A2 PCB assembly	8.5/8.6 8-14/8-15	8.5 8-13
TV TRIGGER A3 PCB assembly	8.7 8-32	8.6 8-32
Accessories replacements	8.8/8.9/8.10/8.11 8-36	8.x 8-36

8.1 INTRODUCTION

The replaceable parts section provides illustrated parts lists for all ScopeMeter test tool Series II models.

The mechanical parts are listed numerically by assembly. The electrical parts on the printed circuit boards A1 and A2 are listed alphanumerically by assembly. Each part is shown in an accompanying illustration.

The parts lists provide the following information for each part:

- Item number
- Figure number
- Description
- Ordering code
- Total quantity of components per assembly

8.2 HOW TO OBTAIN PARTS

Contact an authorized Fluke service center.

To locate an authorized service center refer to the second page of this manual (back of the title page).

To ensure prompt and efficient handling of your order, include the following information:

1. Model number (Fluke xx), Code number (9444 ... .) and Serial number (DM.....). The items are printed on the type plate on the bottom cover.
2. Ordering code
3. Item number
4. Description
5. Quantity

Table 8.1 ScopeMeter test tool final assembly. (See figure 8.1)

When servicing the ScopeMeter test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
1	8.1	Topcover assembly FL92B	5322 442 00222	1
1	8.1	Topcover assembly FL96B	5322 442 00223	1
1	8.1	Topcover assembly FL99B	5322 442 00224	1
1	8.1	Topcover assembly FL105B	5322 442 00225	1
2	8.1	Keypad FL92B	5322 414 20492	1
2	8.1	Keypad FL96B	5322 414 20488	1
2	8.1	Keypad FL99B / FL105B	5322 414 20487	1
16	8.1	Torx screw black M3 x 12	5322 502 13771	2
20	8.1	Torx screw black M3 x 12	5322 502 13771	2
29	8.1	Torx screw blank M3 x 10	5322 502 21507	2
30	8.1	Torx screw blank M3 x 8	5322 502 13772	2
31	8.1	Torx screw black M3 x 12	5322 502 13771	2
		30-pole flat cable, also see page 8-4	5322 321 61238	1
		30-pole extender flat cable for repair purposes	5322 321 61369	1
33	8.1	Torx screw blank M3 x 12	5322 502 21213	2
34	8.1	Top screening A2	5322 447 70129	1
35	8.1	Keypad foil (all models)	5322 218 41052	1
36	8.1	Gasket for optical interface I/O	5322 255 41213	1
37	8.1	3 mm spacer	5322 532 20577	2
38	8.1	Bottom screening A2	5322 466 83171	1
39	8.1	Top screening A1 (CE)	5322 466 10709	1
40	8.1	Torx screw blank M3 x 8	5322 502 13772	2

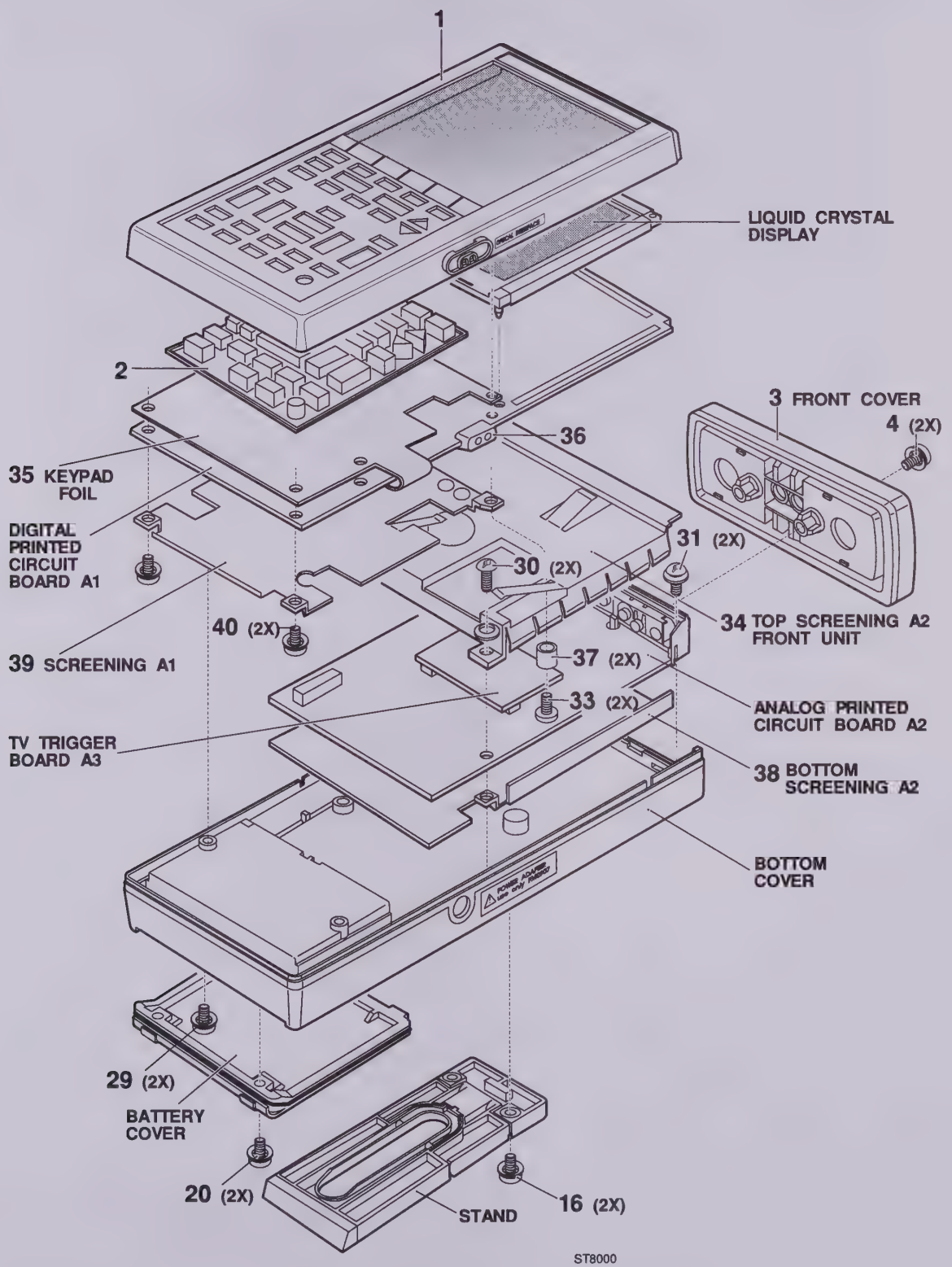


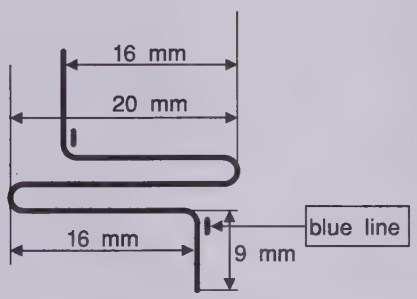
Figure 8.1 ScopeMeter test tool final assembly

Table 8.2 Front cover assembly (See figure 8.2)
Input unit assembly
Display asssembly

When servicing the ScopeMeter test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
3	8.2	Front cover assembly 92B, 96B, 99B, 105B	5322 447 92298	1
4	8.2	Torx screw black M3 x 12	5322 502 13771	2
5	8.2	Input unit assembly 92B, 96B, 99B, 105B	5322 218 61462	1
7	8.2	LCD frame	5322 256 10192	1
8	8.2	LCD clamps	5322 401 11411	3
9	8.2	LCD contact strip L-shape	5322 460 11045	2
10	8.2	LCD contact strip I-shape	5322 460 11046	1
11	8.2	LCD display (all models)	5322 135 00027	1
12	8.2	Bracket for lightguide	)*	1
13	8.2	Lightguide + CCFL	)*	1

)* The CCFL lamp can not be replaced in the field. When the lamp is defective you must replace the complete A1 board.



Measurements how to fold the flat cable

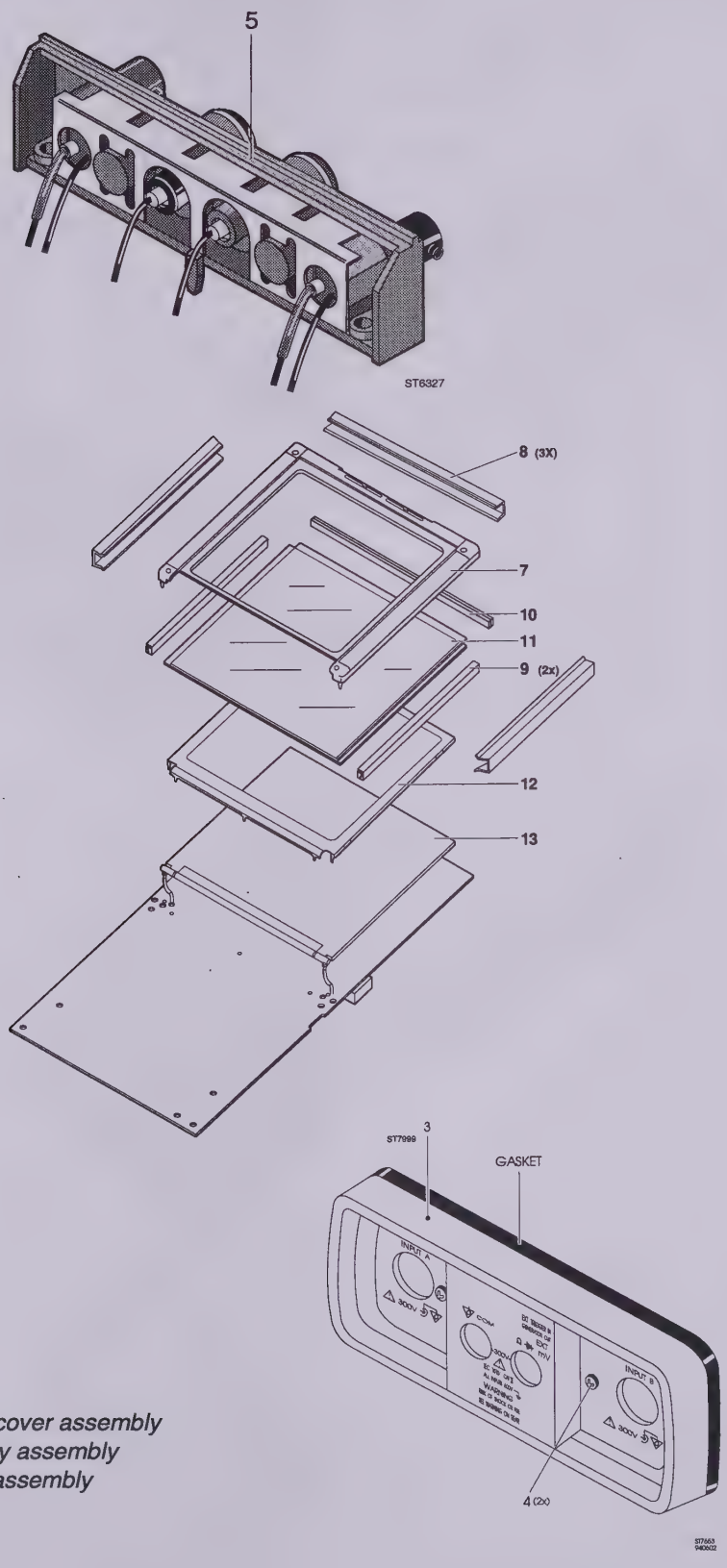


Figure 8.2 Front cover assembly
Display assembly
Input assembly

Table 8.3 Battery contact assembly. (See figure 8.3)
Stand assembly
Battery cover assembly
Bottom cover assembly

When servicing the ScopeMeter test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
14	8.3	Stand assembly (item 15+16 included)	5322 456 90416	1
15	8.3	Anti slip strip	5322 466 62045	1
16	8.3	Torx screw black M3x10	5322 502 13771	1
17	8.3	Battery cover assembly	5322 447 70116	1
18	8.3	Gasket	5322 530 51238	1
19	8.3	Rubber foot	5322 462 41825	2
20	8.3	Torx screw black M3x10	5322 502 13771	2
21	8.3	Bottom cover assembly	5322 447 70113	1
22	8.3	Battery contact spring	5322 492 70908	3
23	8.3	Battery contact spring assembly	5322 492 70909	1
24	8.3	Buffer	5322 466 62047	4
25	8.3	12V/0 contact	5322 466 82843	2
26	8.3	Charging contact	5322 466 82842	1
27	8.3	Battery wiring assembly	5322 321 62997	1
27	8.3	New Battery wiring assembly (PCN4264)	5322 323 10359	1
28	8.3	Battery pull strip	5322 466 62046	1

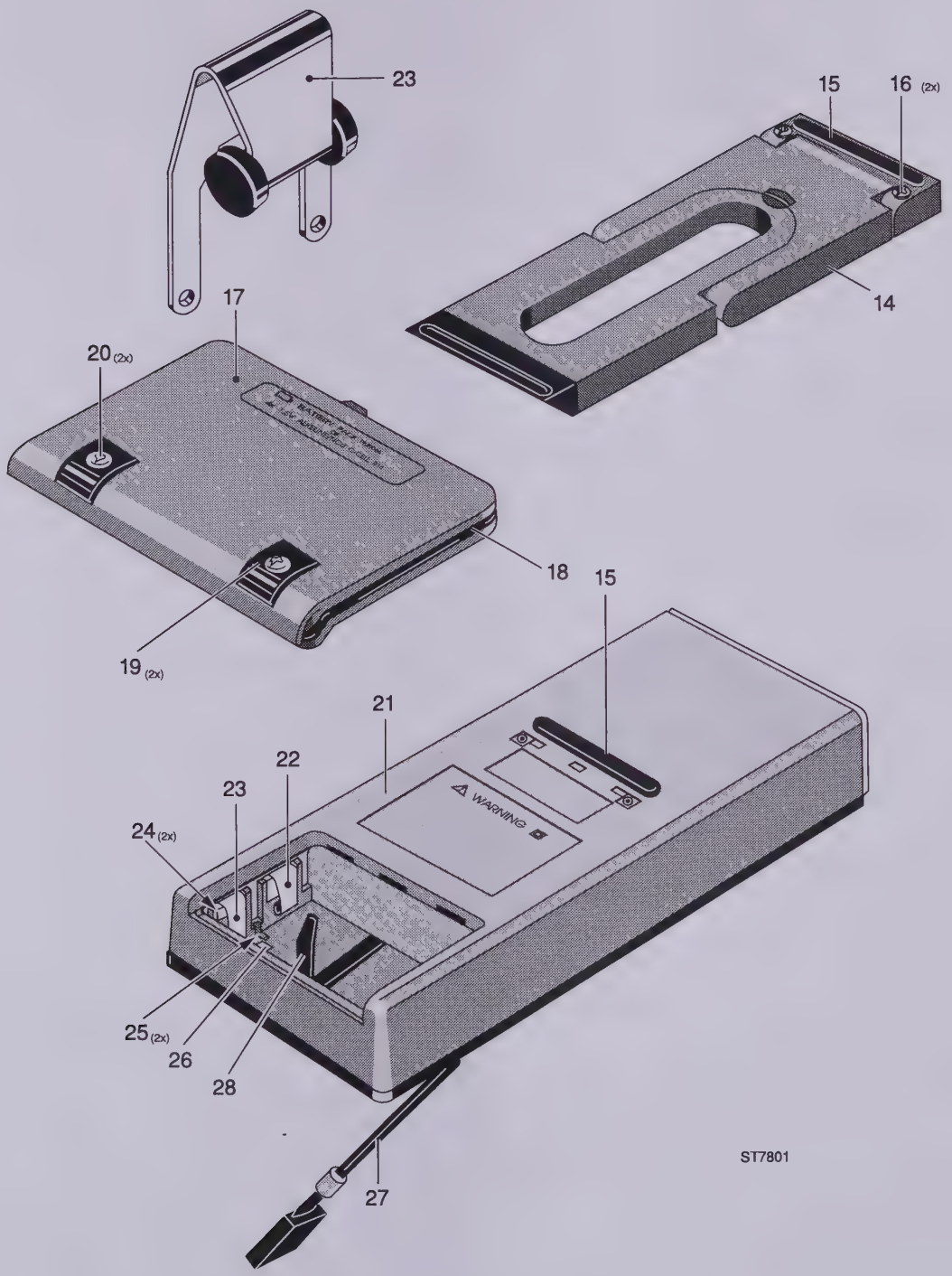


Figure 8.1 *Battery contact assembly*
Stand assembly
Battery cover assembly
Bottom assembly

Table 8.3 Battery contact assembly. (See figure 8.3)
Stand assembly
Battery cover assembly
Bottom cover assembly

When servicing the ScopeMeter test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
14	8.3	Stand assembly (item 15+16 included)	5322 456 90416	1
15	8.3	Anti slip strip	5322 466 62045	1
16	8.3	Torx screw black M3x10	5322 502 13771	1
17	8.3	Battery cover assembly	5322 447 70116	1
18	8.3	Gasket	5322 530 51238	1
19	8.3	Rubber foot	5322 462 41825	2
20	8.3	Torx screw black M3x10	5322 502 13771	2
21	8.3	Bottom cover assembly	5322 447 70113	1
22	8.3	Battery contact spring	5322 492 70908	3
23	8.3	Battery contact spring assembly	5322 492 70909	1
24	8.3	Buffer	5322 466 62047	4
25	8.3	12V/0 contact	5322 466 82843	2
26	8.3	Charging contact	5322 466 82842	1
27	8.3	Battery wiring assembly	5322 321 62997	1
27	8.3	New Battery wiring assembly (PCN4264)	5322 323 10359	1
28	8.3	Battery pull strip	5322 466 62046	1

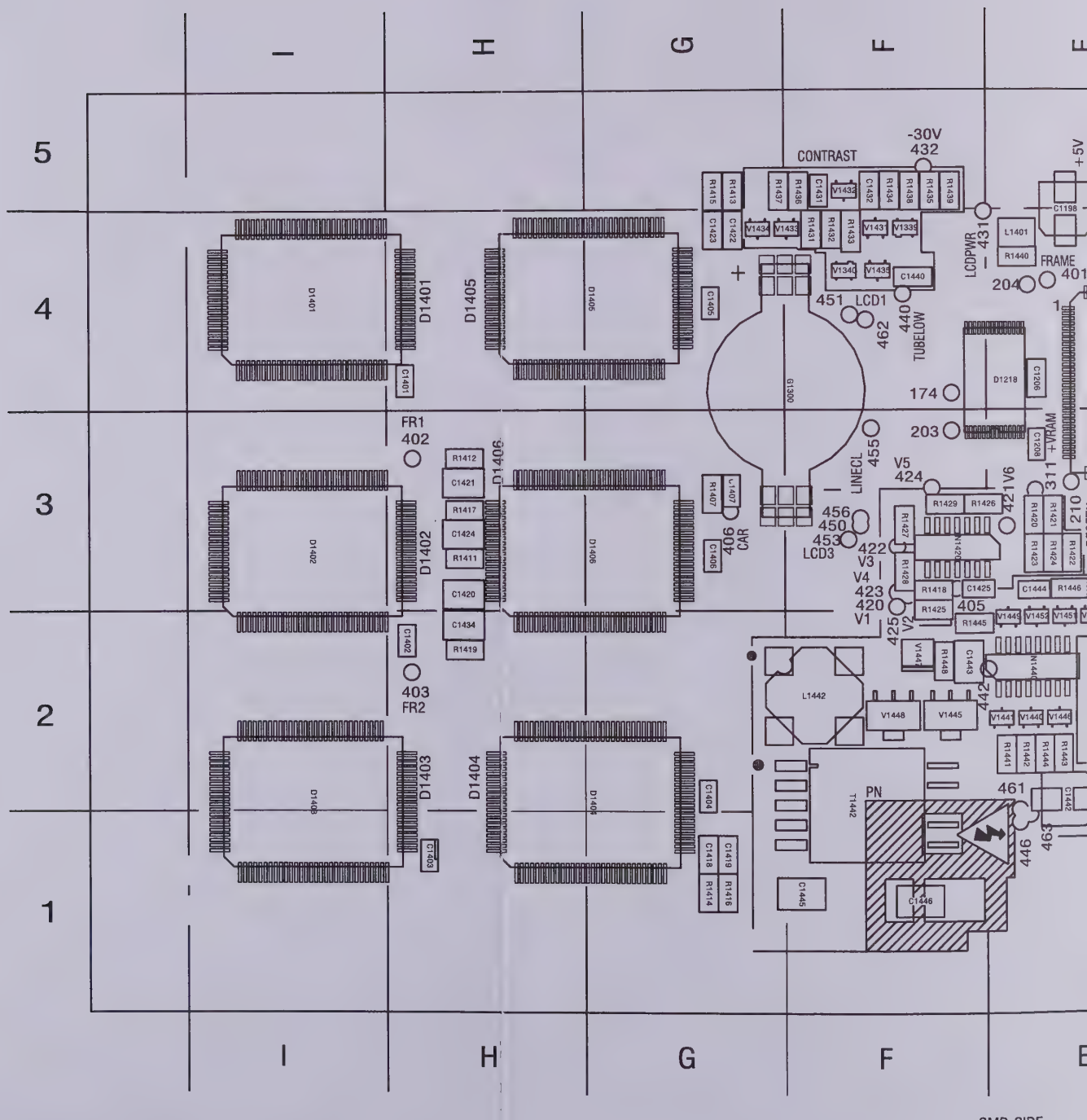


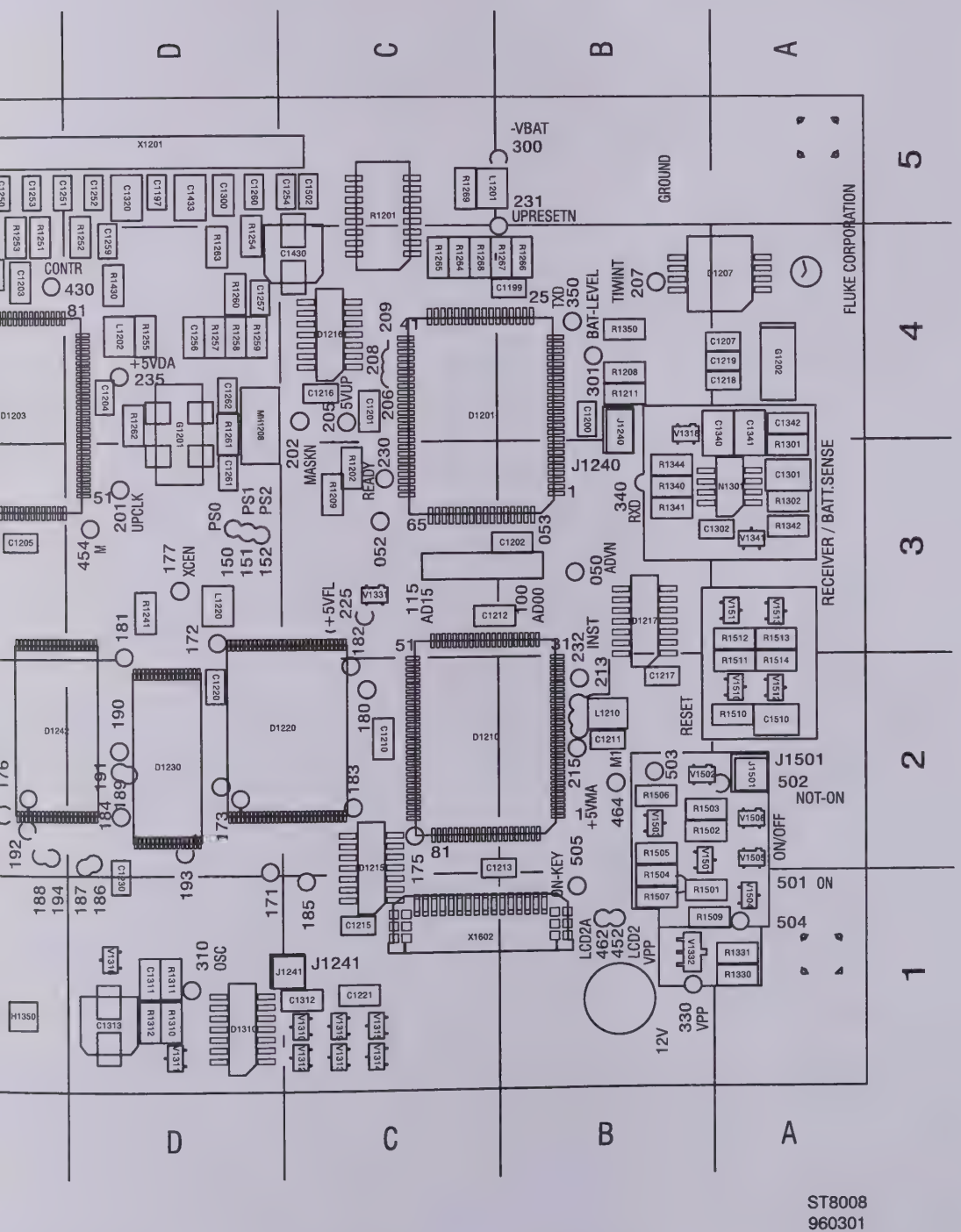
Figure 8.4 Digital A1 PCB assembly

Table 8.4 Digital A1 PCB assembly (figure 8.4)

When servicing the ScopeMeter® test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
A1	8.4	Digital A1 PCB assembly)*	5322 216 04041	1

)* After replacement by a new A1 PCB, you must load the correct firmware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C
B
A
5
4
3
2
1
X1201
-VBAT
300
231
UPRESETN
GROUND
FLUKE CORPORATION
CONTR
430
81
+5VDA
235
D1203
D1201
D1216
D1207
R1350
BAT-LEVEL
TIWINT
207
TXD
350
301
R1208
R1211
J1240
202
MASKN
READY
230
205
206
209
208
5VDP
340
RXD
RECEIVER / BATT.SENSE
51
201
UPCLK
PS0
PS1
PS2
150
151
152
177
XCEN
454
M
052
053
050
ADVN
115
AD15
100
AD00
(+5VFL
225
181
172
182
51
31
232
INST
213
D1217
D1242
D1220
D1230
D1210
190
191
189
184
183
180
173
215
+5VMA
464
M1
503
RESET
J1501
502
NOT-ON
ON/OFF
501
ON
504
192
188
194
187
186
193
171
185
175
81
ON-KEY
505
LCD2A
462
LCD2
452
VPP
330
12V
X1602
H1350
310
OSC
J1241
R1331
R1330
R1512
R1513
R1511
R1514
R1510
C1510
R1506
R1503
R1502
R1505
R1504
R1507
R1501
R1509
R1344
R1340
R1341
R1301
R1302
R1342
C1301
C1302
N1301
V1341
V1318
R1201
L1201
R1269
R1265
R1264
R1268
R1267
R1266
C1199
C1430
C1207
C1219
C1218
G1202
C1340
C1341
C1342
J1240
C1200
C1202
C1212
C1217
C1210
L1210
C1211
C1213
C1215
C1221
C1312
C1313
C1311
R1311
R1312
R1310
D1310
V131
V1501
V1502
V1503
V1504
V1505
V1506
V1507
V1508
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V1510
V1511
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V1519
V1520
V1521
V1522
V1523
V1524
V1525
V1526
V1527
V1528
V1529
V1530
V1531
V1532
V1533
V1534
V1535
V1536
V1537
V1538
V1539
V1540

Item	Description	Ordering code
A1 BOARD		
CAPACITORS		
C1197	63V 10% 22NF	5322 122 32654
C1198	50V 20% 10UF	5322 124 42332
C1199	63V 10% 22NF	5322 122 32654
C1200	63V 10% 22NF	5322 122 32654
C1201	63V 10% 100NF	4822 122 33496
C1202	63V 10% 100NF	4822 122 33496
C1203	63V 10% 100NF	4822 122 33496
C1204	63V 10% 22NF	5322 122 32654
C1205	63V 10% 22NF	5322 122 32654
C1206	63V 10% 100NF	4822 122 33496
C1207	63V 10% 22NF	5322 122 32654
C1208	63V 10% 22NF	5322 122 32654
C1210	63V 10% 100NF	4822 122 33496
C1211	63V 10% 22NF	5322 122 32654
C1212	63V 10% 100NF	4822 122 33496
C1213	63V 10% 22NF	5322 122 32654
C1215	63V 10% 10NF	5322 122 34098
C1216	63V 10% 22NF	5322 122 32654
C1217	63V 10% 22NF	5322 122 32654
C1218	63V 0.5PF 8.2PF	5322 122 33244
C1219	63V 5% 15PF	5322 122 33869
C1220	63V 10% 22NF	5322 122 32654
C1221	63V 10% 100NF	4822 122 33496
C1230	63V 10% 22NF	5322 122 32654
C1240	63V 10% 22NF	5322 122 32654
C1250	63V 10% 10NF	5322 122 34098
C1251	63V 10% 10NF	5322 122 34098
C1252	63V 10% 10NF	5322 122 34098
C1253	63V 10% 10NF	5322 122 34098
C1254	63V 5% 15PF	5322 122 33869
C1256	63V 10% 100NF	4822 122 33496
C1257	63V 5% 10PF	5322 122 32448
C1259	63V 5% 680PF	5322 126 10733
C1260	63V 10% 22NF	5322 122 32654
C1261	63V 5% 15PF	5322 122 33869
C1262	63V 5% 15PF	5322 122 33869
C1300	63V 10% 100NF	4822 122 33496
C1301	63V 10% 220NF	4822 122 32916
C1302	63V 10% 22NF	5322 122 32654
C1311	63V 10% 2.7NF	4822 122 33498
C1312	63V 10% 100NF	4822 122 33496
C1313	6.3V 20% 100UF	5322 124 42331
C1320	63V 10% 220NF	4822 122 32916
C1340	63V 10% 220NF	4822 122 32916
C1341	63V 10% 220NF	4822 122 32916

Item	Description	Ordering code
C1342	63V 10% 2.7NF	4822 122 33498
C1401	63V 10% 22NF	5322 122 32654
C1402	63V 10% 22NF	5322 122 32654
C1403	63V 10% 22NF	5322 122 32654
C1404	63V 10% 22NF	5322 122 32654
C1405	63V 10% 22NF	5322 122 32654
C1406	63V 10% 22NF	5322 122 32654
C1407	63V 5% 120PF	5322 122 33861
C1418	63V 10% 100NF	4822 122 33496
C1419	63V 10% 100NF	4822 122 33496
C1420	63V 10% 220NF	4822 122 32916
C1421	63V 10% 220NF	4822 122 32916
C1422	63V 10% 100NF	4822 122 33496
C1423	63V 10% 100NF	4822 122 33496
C1424	63V 10% 220NF	4822 122 32916
C1425	63V 10% 22NF	5322 122 32654
C1430	50V 20% 10UF	5322 124 42332
C1431	63V 5% 680PF	5322 126 10733
C1432	63V 10% 100NF	4822 122 33496
C1433	63V 10% 220NF	4822 122 32916
C1434	63V 10% 220NF	4822 122 32916
C1440	63V 10% 100NF	4822 122 33496
C1442	50V 20% 10UF	5322 124 42332
C1443	25V 10% 1UF	5322 126 13826
C1444	63V 5% 1NF	5322 126 10511
C1445	25V 10% 150NF	5322 123 14013
C1502	63V 10% 10NF	5322 122 34098
C1510	63V 10% 220NF	4822 122 32916

DIGITAL INTEGRATED CIRCUITS

D1201	CONTROLER	5322 209 12591
D1203	DASIC	5322 209 30819
D1207	256X8SRAM PCF8583T/F4	4822 209 32504
D1210	MEM MANAGER MASIC	5322 209 32946
D1215	4X2-INP SCHM 74HC132	5322 209 60428
D1216	4X2-INP SCHM 74HC132	5322 209 60428
D1217	74HC74D PEL	5322 209 71589
D1218	32KX8SRAM M5M5256CRV-70LL	5322 209 52729
D1221	IMB FEPROM E28F010-120INT	5322 209 52456
D1230	128K SRAM M5M51008ARV-70LL	5322 209 52707
D1242	4MB FEPROM E28F004BX	5322 209 52714
D1310	4X2-IN SMTR HEF4093B	5322 209 11147
D1401	LCD DRIVER HD66205F	5322 209 52458
D1402	LCD DRIVER HD66205F	5322 209 52458
D1403	LCD DRIVER HD66205F	5322 209 52458
D1404	LCD DRIVER HD66204F	5322 209 52457
D1405	LCD DRIVER HD66204F	5322 209 52457
D1406	LCD DRIVER HD66204F	5322 209 52457

Item	Description	Ordering code
BATTERY / CRYSTAL		
G1	LITH BATT 3V/190MAH	4822 138 10464
G1201	CRISTAL 25MHZ	5322 242 81633
G1202	CRYSTAL 32.768KHZ	5322 242 10302
G1300	BATTERY HOLDER	5322 256 60343
OPTO DEVICES		
H1340	SFH309F-4 SIE	4822 130 62297
H1350	SFH409-2 SIE	5322 130 61296
H1401	LCD 0 TRANSFLECTIVE	5322 130 91054
COILS		
L1201	1UH 5%	5322 157 63648
L1202	HF30ACB-322513T	5322 157 63651
L1203	1UH 5%	5322 157 63648
L1210	1UH 5%	5322 157 63648
L1220	1UH 5%	5322 157 63648
L1401	1UH 5%	5322 157 63648
L1442	TRAFO CTX100-4 CLT	5322 146 10406
L1443	TRAFO	5322 157 11278
ANALOG INTEGRATED CIRCUITS		
N1301	2XOPAMP LM358M	5322 209 82941
N1420	4XOPAMP LM324D	5322 209 83125
N1440	LT1184CS REGULATOR	5322 209 12971
RESISTORS		
R1201	RES NETWORK 56K	5322 111 91993
R1202	CHIP RC-01 0E	4822 051 10008
R1208	RC-02H 1% 11K0	4822 051 10113
R1209	CHIP RC-01 0E	4822 051 10008
R1241	CHIP RC-01 0E	4822 051 10008
R1250	CHIP RC-02 11K 1%	4822 051 10113
R1251	CHIP RC-02 11K 1%	4822 051 10113
R1252	CHIP RC-02 11K 1%	4822 051 10113
R1253	CHIP RC-02H 5K62 1%	5322 117 10573
R1254	CHIP RC-02H 1K 1%	4822 051 10102
R1255	CHIP RC-02H 1K 1%	4822 051 10102
R1257	CHIP RC-02H 11K 1%	4822 051 10113
R1258	CHIP RC-02H 51K1 1%	4822 051 55113
R1259	CHIP RC-02H 11K0 1%	4822 051 10113
R1260	CHIP RC-02H 1K0 1%	4822 051 10103
R1261	CHIP RC-02H 1M0 1%	4822 051 10105
R1262	CHIP RC-02H 121E 1%	4822 051 51211
R1263	CHIP RC-02H 261E 1%	4822 051 52611
R1264	CHIP RC-02H 1K0 1%	4822 051 10102
R1265	CHIP RC-02H 1K0 1%	4822 051 10102

Item	Description	Ordering code
R1266	CHIP RC-02H 1K0 1%	4822 051 10102
R1267	CHIP RC-02H 1K0 1%	4822 051 10102
R1268	CHIP RC-02H 1K0 1%	4822 051 10102
R1269	CHIP RC-02H 121E 1%	4822 051 51211
R1301	CHIP RC-02H 121K 1%	4822 051 51214
R1302	CHIP RC-02H 90K9 1%	5322 117 11754
R1310	CHIP RC-02H 34K8 1%	5322 117 10558
R1311	CHIP RC-02H 121E 1%	4822 051 51211
R1312	CHIP RC-02H 2K15 1%	5322 117 10485
R1330	CHIP RC-02H 1K0 1%	4822 051 10102
R1331	CHIP RC-02H 681E 1%	5322 117 10579
R1340	CHIP RC-02H 464K 1%	5322 117 10568
R1341	CHIP RC-02H 1K0 1%	4822 051 10102
R1342	CHIP RC-02H 1K0 1%	4822 051 10102
R1344	CHIP RC-02H 11K 1%	4822 051 10113
R1350	CHIP RC-02H 383E 1%	5322 117 10559
R1407	CHIP RC-02H 1K0 1%	4822 051 10102
R1411	CHIP RC-02H 100E 1%	4822 051 10101
R1412	CHIP RC-02H 100E 1%	4822 051 10101
R1413	CHIP RC-02H 215E 1%	5322 117 10484
R1414	CHIP RC-02H 215E 1%	5322 117 10484
R1415	CHIP RC-02H 215E 1%	5322 117 10484
R1416	CHIP RC-02H 215E 1%	5322 117 10484
R1417	CHIP RC-02H 100E 1%	4822 051 10101
R1418	D2542R2FCS 42E2	5322 117 11753
R1419	CHIP RC-02H 100E 1%	4822 051 10101
R1420	CHIP RC-02H 5K62 1%	5322 117 10573
R1421	CHIP RC-02H 5K62 1%	5322 117 10573
R1422	CHIP RC-02H 61K9 1%	5322 117 10578
R1423	CHIP RC-02H 5K62 1%	5322 117 10573
R1424	CHIP RC-02H 5K62 1%	5322 117 10573
R1425	D2542R2FCS 42E2	5322 117 11753
R1426	D2551R1FCS 51E1	5322 117 11737
R1427	D2551R1FCS 51E1	5322 117 11737
R1428	D2551R1FCS 51E1	5322 117 11737
R1429	D2551R1FCS 51E1	5322 117 11737
R1430	CHIP RC-02H 11K0 1%	4822 051 10113
R1431	CHIP RC-02H 2K15 1%	5322 117 10485
R1432	CHIP RC-02H 3K48 1%	5322 117 10557
R1433	TEMP. SENSOR	5322 130 91332
R1434	CHIP RC-02H 11K0 1%	4822 051 10113
R1435	CHIP RC-02H 82k5	4822 051 58253
R1436	CHIP RC-02H 1K0 1%	4822 051 10102
R1437	CHIP RC-02H 19K6 1%	5322 117 10541
R1438	CHIP RC-02H 11K0 1%	4822 051 10113
R1439	D2551R1FCS 75Ω	5322 117 11741
R1440	RC-02H 1% 100K	4822 051 10104
R1441	RC-02H 1% 147K	4822 051 51474
R1442	RC-02H 1% 464K	5322 117 10568

Item	Description	Ordering code
R1443	RC-02H 1% 100K	4822 051 10104
R1444	RC-02H 1% 51K1	4822 051 55113
R1445	RC-02H 1% 100K	4822 051 10104
R1446	RC-02H 1% 2K87	5322 117 10549
R1448	RC-02H 1% 750E	5322 117 10582
R1501	CHIP RC-02H 100K 1%	4822 051 10104
R1502	CHIP RC-02H 100K 1%	4822 051 10104
R1503	CHIP RC-02H 100K 1%	4822 051 10104
R1504	CHIP RC-02H 1K0 1%	4822 051 10102
R1505	CHIP RC-02H 100K 1%	4822 051 10104
R1506	CHIP RC-02H 100K 1%	4822 051 10104
R1507	CHIP RC-02H 11K0 1%	4822 051 10113
R1509	CHIP RC-01 0E 1%	4822 051 10008
R1510	CHIP RC-02H 215E 1%	5322 117 10484
R1511	CHIP RC-02H 11K0 1%	4822 051 10113
R1512	CHIP RC-02H 121E 1%	4822 051 51211
R1513	CHIP RC-02H 11K0 1%	4822 051 10113
R1514	CHIP RC-02H 1M0 1%	4822 051 10105

TRANSFORMER

T1442	TRNSFRMR CTX210657	5322 146 10405
T1443	TRNSFRMR	5322 146 10802

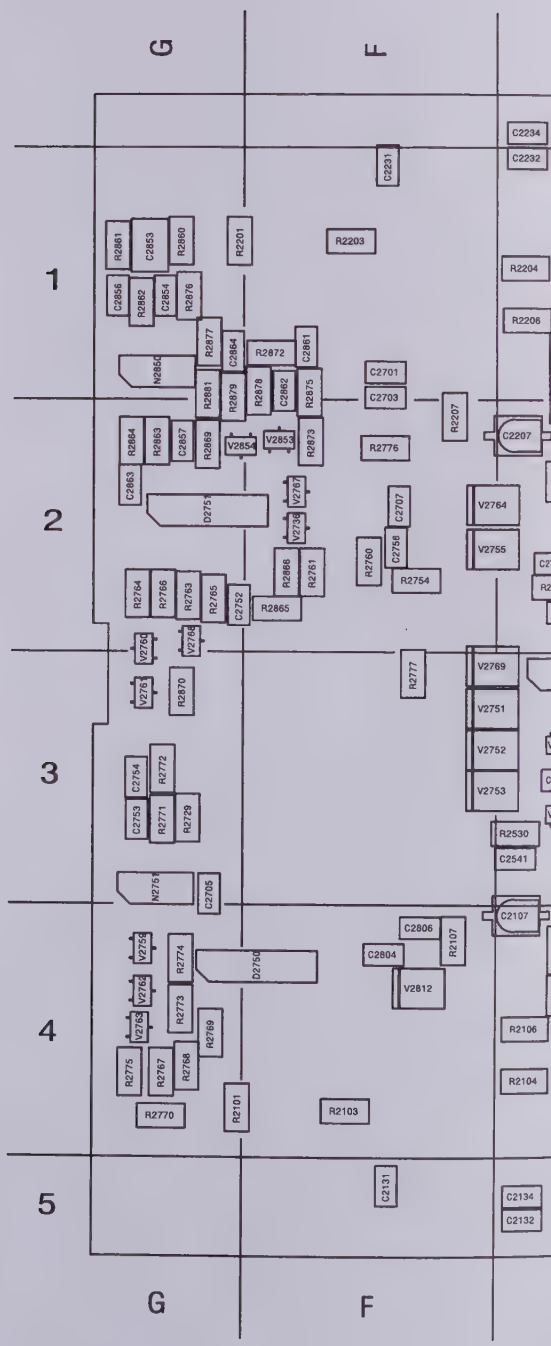
DIODES/TRANSISTORS

V1310	BAT54S	4822 130 82262
V1311	BC858C	4822 130 42513
V1312	BC848C	5322 130 42136
V1313	BC848C	5322 130 42136
V1314	BC848C	5322 130 42136
V1315	BC848C	5322 130 42136
V1316	BC807	4822 130 42132
V1318	BAS28	5322 130 80214
V1319	BC848C	5322 130 42136
V1331	BAS28	5322 130 80214
V1332	BZV49-C13	5322 130 82043
V1339	BAS28 PEL	5322 130 80214
V1340	BAS28	5322 130 80214
V1341	BC848C	5322 130 42136
V1431	BC858C	4822 130 42513
V1432	BC848C	5322 130 42136
V1433	BC857B	5322 130 60508
V1434	Zener DIODE B 2x84-B24	4822 130 82709
V1435	BC848C	5322 130 42136
V1440	BC858C	4822 130 42513
V1440	BC858C PEL	4822 130 42513
V1441	BC858C	4822 130 42513
V1445	FZT849 ZTX	5322 130 10191
V1446	BC858C PEL	4822 130 42513
V1447	PRLL5818 PEL	4822 130 83799

Item	Description	Ordering code
V1448	FZT849 PEL	5322 130 10191
V1449	BAT54S PEL	4822 130 82262
V1450	BC848C PEL	5322 130 42136
V1451	BC858C PEL	4822 130 42513
V1452	BZX84-C3V6 PEL	5322 130 32731
V1501	BC858C	4822 130 42513
V1502	BAS28	5322 130 80214
V1503	BC848C	5322 130 42136
V1504	BC848C	5322 130 42136
V1505	BAS28	5322 130 80214
V1506	BAS28	5322 130 80214
V1510	BC858C	4822 130 42513
V1511	BZX84-C3V6	5322 130 32731
V1512	BC858C	4822 130 42513
V1513	BC858C	4822 130 42513

CONNECTORS

X1201	30-P 1.25 MM RECHT	5322 267 70302
X1602	CONNECTOR 16P	5322 267 51318


G
F
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2
3
4
5
C2234
C2232
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R2206
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C2853
R2860
C2856
R2862
C2854
R2876
R2877
C2864
R2872
C2861
N2850
R2881
R2879
R2878
C2862
R2875
C2701
C2703
R2207
C2207
R2884
R2863
C2857
R2869
V2854
V2853
R2873
R2776
C2863
D2754
V2705
V2706
C2707
V2764
V2755
R2760
C2756
R2754
R2866
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R2777
R2870
V2751
V2752
V2753
C2754
R2772
C2753
R2771
R2729
R2530
C2541
N2751
C2705
C2107
C2806
R2107
C2804
V2812
V2758
R2774
D2750
V2757
R2773
R2769
R2106
R2104
R2775
R2767
R2758
R2770
R2101
R2103
C2131
C2134
C2132

Table 8.5 Analog A2 PCB assembly (Figure 8.5)

When servicing the ScopeMeter® test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
A2	8.5/8.6	Analog A2 PCB assembly 92B, 96B	5322 216 04042	1
A2	8.5/8.6	Analog A2 PCB assembly 99B, 105B	5322 216 04043	1

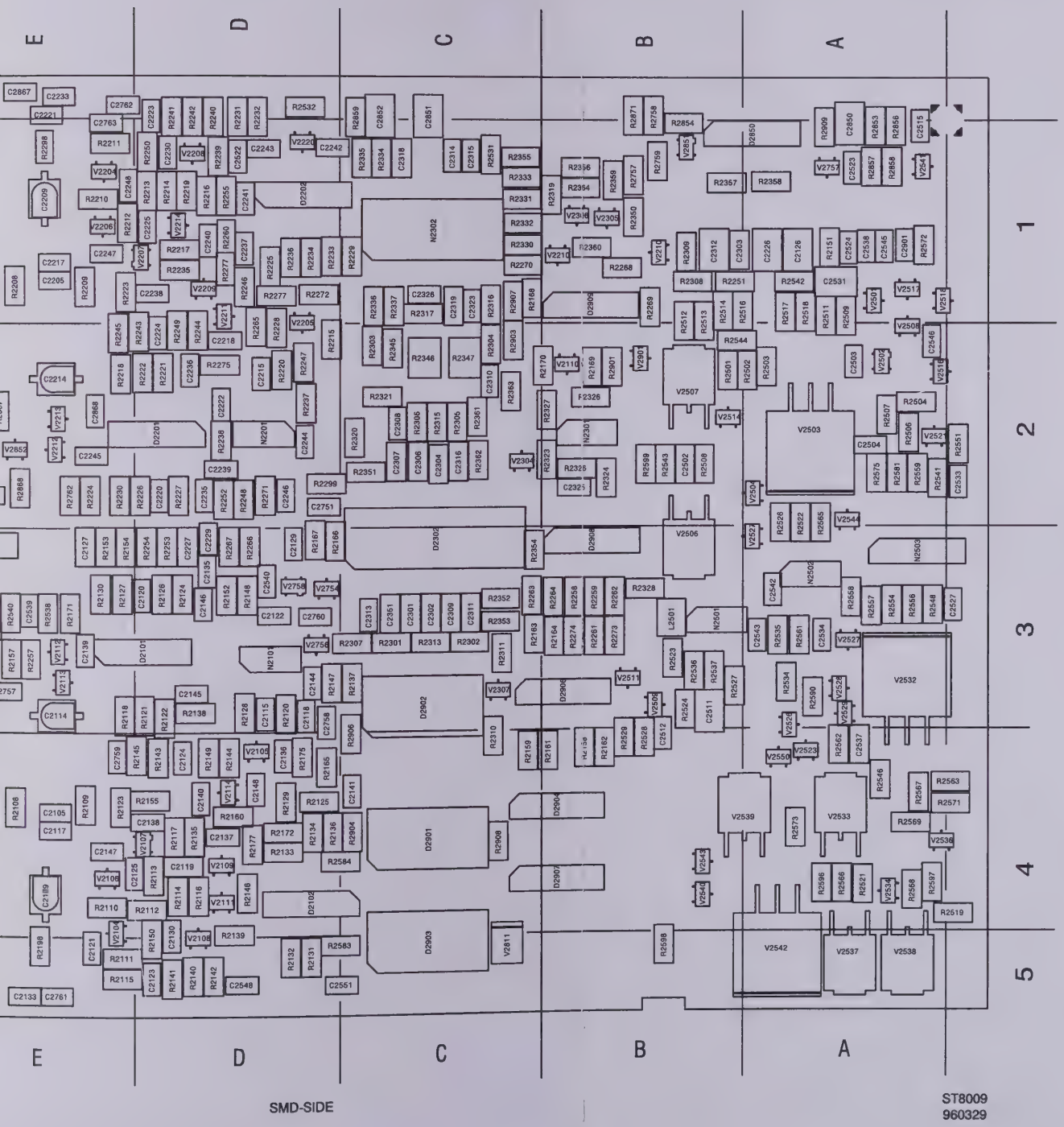


Figure 8.5 Analog A2 PCB assembly SMD component side

Item	Description	Ordering code
A2 BOARD		
CAPACITORS		
C2102	400V 10% 22NF	5322 121 70399
C2103	500V 2% 56PF	5322 122 32982
C2104	500V 0.25PF 8.2PF	4822 122 31194
C2105	CAP 63V 5% 12PF	4822 122 33926
C2106	500V 2% 10PF	5322 126 13328
C2107	CAP 3-10 PF MUR	5322 125 50306
C2108	100V 2% 47PF	4822 122 31072
C2109	CAP 3-10 PF MUR	5322 125 50306
C2111	500V 0.25PF 6.8PF	5322 126 13327
C2112	500V 0.25PF 6.8PF	5322 126 13327
C2113	100V 2% 56PF	5322 126 13329
C2114	CAP 3-10 PF MUR	5322 125 50306
C2115	CAP 63V 5% 12PF	4822 122 33926
C2116	500V 0.25PF 8.2PF	4822 122 31194
C2117	CAP 63V 2% 56PF	4822 126 13693
C2118	CAP 63V 5% 330PF	5322 122 31863
C2119	CAP 63V 10% 100NF	4822 122 33496
C2120	CAP 63V 0.5PF 5.6PF	5322 122 32967
C2121	CAP 63V 10% 10NF	5322 122 34098
C2122	CAP 63V 10% 3.3NF	4822 122 33891
C2123	CAP 63V 5% 1NF	5322 126 10511
C2124	CAP 63V 10% 3.3NF	4822 122 33891
C2125	CAP 63V 5% 120PF	5322 122 33861
C2126	CAP 63V 10% 220NF	4822 122 32916
C2127	CAP 63V 10% 68NF	4822 122 32891
C2128	63V 0.5PF 6.8PF	5322 122 32269
C2129	CAP 63V 10% 3.3NF	4822 122 33891
C2130	CAP 63V 10% 10NF	5322 122 34098
C2131	CAP 63V 10% 10NF	5322 122 34098
C2132	CAP 63V 10% 10NF	5322 122 34098
C2133	CAP 63V 10% 10NF	5322 122 34098
C2134	CAP 63V 10% 10NF	5322 122 34098
C2135	CAP 63V 10% 22NF	5322 122 32654
C2136	CAP 63V 5% 680PF	5322 126 10733
C2137	CAP 63V 5% 82PF	4822 122 33515
C2138	CAP 63V 10% 22NF	5322 122 32654
C2139	CAP 63V 10% 2.2NF	4822 122 33127
C2140	CAP 63V 10% 22NF	5322 122 32654
C2141	CAP 63V 10% 2.2NF	4822 122 33127
C2144	CAP 63V 10% 2.2NF	4822 122 33127
C2145	CAP 63V 10% 2.2NF	4822 122 33127
C2146	CAP 63V 10% 2.2NF	4822 122 33127
C2147	CAP 63V 10% 2.2NF	4822 122 33127
C2148	CAP 63V 10% 2.2NF	4822 122 33127
C2149	0.22UF	5322 121 90063
C2150	1KV -20+80% 4.7NF	5322 126 13825

Item	Description	Ordering code
C2151	63V 5% 10PF	5322 122 32448
C2202	CAP 400V 10% 22NF	5322 121 70399
C2203	500V 2% 56PF	5322 122 32982
C2204	500V 0.25PF 8.2PF	4822 122 31194
C2205	CAP 63V 5% 12PF	4822 122 33926
C2206	500V 2% 10PF	5322 126 13328
C2207	CAP 3-10 PF MUR	5322 125 50306
C2208	100V 2% 47PF	4822 122 31072
C2209	CAP 3-10 PF MUR	5322 125 50306
C2211	500V 0.25PF 6.8PF	5322 126 13327
C2212	500V 0.25PF 6.8PF	5322 126 13327
C2213	100V 2% 56PF	5322 126 13329
C2214	CAP 3-10 PF MUR	5322 125 50306
C2215	CAP 63V 5% 12PF	4822 122 33926
C2216	500V 0.25PF 8.2PF	4822 122 31194
C2217	CAP 63V 2% 56PF	4822 126 13693
C2218	CAP 63V 5% 270PF	4822 122 33216
C2219	CAP 63V 10% 100NF	4822 122 33496
C2220	CAP 63V 0.5PF 5.6PF	5322 122 32967
C2221	CAP 63V 10% 10NF	5322 122 34098
C2222	CAP 63V 10% 3.3NF	4822 122 33891
C2223	CAP 63V 5% 1NF	5322 126 10511
C2224	CAP 63V 10% 3.3NF	4822 122 33891
C2225	CAP 63V 5% 120PF	5322 122 33861
C2226	CAP 63V 10% 220NF	4822 122 32916
C2227	CAP 63V 10% 68NF	4822 122 32891
C2228	63V 0.5PF 6.8PF	5322 122 32269
C2229	CAP 63V 10% 3.3NF	4822 122 33891
C2230	CAP 63V 10% 10NF	5322 122 34098
C2231	CAP 63V 10% 10NF	5322 122 34098
C2232	CAP 63V 10% 10NF	5322 122 34098
C2233	CAP 63V 10% 10NF	5322 122 34098
C2234	CAP 63V 10% 10NF	5322 122 34098
C2235	CAP 63V 10% 22NF	5322 122 32654
C2236	CAP 63V 5% 680PF	5322 126 10733
C2237	CAP 63V 5% 82PF	4822 122 33515
C2238	CAP 63V 10% 22NF	5322 122 32654
C2239	CAP 63V 10% 2.2NF	4822 122 33127
C2240	CAP 63V 10% 22NF	5322 122 32654
C2241	CAP 63V 10% 2.2NF	4822 122 33127
C2242	CAP 63V 10% 2.2NF	4822 122 33127
C2243	CAP 63V 10% 2.2NF	4822 122 33127
C2244	CAP 63V 10% 2.2NF	4822 122 33127
C2245	CAP 63V 10% 2.2NF	4822 122 33127
C2246	CAP 63V 10% 2.2NF	4822 122 33127
C2247	CAP 63V 10% 2.2NF	4822 122 33127
C2248	CAP 63V 10% 2.2NF	4822 122 33127
C2249	0.22UF	5322 121 90063
C2250	1KV -20+80% 4.7NF	5322 126 13825
C2251	63V 5% 10PF	5322 122 32448

Item	Description	Ordering code
C2255	63V 10% 220NF	4822 122 32916
C2301	CAP 63V 10% 100NF	4822 122 33496
C2302	CAP 63V 10% 100NF	4822 122 33496
C2303	CAP 63V 10% 100NF	4822 122 33496
C2304	CAP 63V 10% 100NF	4822 122 33496
C2306	CAP 63V 10% 100NF	4822 122 33496
C2307	CAP 63V 10% 100NF	4822 122 33496
C2308	CAP 63V 10% 10NF	5322 122 34098
C2309	CAP 63V 10% 100NF	4822 122 33496
C2310	CAP 63V 10% 10NF	5322 122 34098
C2311	CAP 63V 10% 100NF	4822 122 33496
C2312	CAP 63V 10% 220NF	4822 122 32916
C2313	CAP 63V 10% 22NF	5322 122 32654
C2314	CAP 63V 10% 22NF	5322 122 32654
C2315	CAP 63V 0.25PF 1PF	5322 122 32447
C2316	CAP 63V 10% 100NF	4822 122 33496
C2317	16V 20% 68UF	4822 124 11162
C2318	CAP 63V 10% 100NF	4822 122 33496
C2319	CAP 63V 10% 100NF	4822 122 33496
C2322	50V 20% 4.7UF	4822 124 23627
C2323	CAP 63V 10% 2.2NF	4822 122 33127
C2324	50V 20% 4.7UF	4822 124 23627
C2326	CAP 63V 5% 47PF	5322 122 32452
C2351	CAP 63V 10% 100NF	4822 122 33496
C2501	20% 470UF	5322 121 43885
C2502	CAP 63V 10% 68NF	4822 122 32891
C2502	63V 10% 68NF(PCB.2)	5322 126 13624
C2503	CAP 63V 10% 2.2NF	4822 122 33127
C2504	CAP 63V 10% 22NF	4822 122 32654
C2505	CAP 100V 10% 220NF (board .1, B-2)	4822 122 32916
C2505	CAP 100V 10% 100NF (board .3, B-2)	5322 126 13186
C2506	20% 1200UF	5322 121 43884
C2507	20% 180UF	5322 121 43886
C2508	20% 1200UF	5322 121 43884
C2509	16V 20% 68UF	4822 124 11162
C2511	CAP 63V 10% 220NF	4822 122 32916
C2512	CAP 63V 10% 22NF	5322 122 32654
C2514	16V 20% 68UF	4822 124 11162
C2515	CAP 63V 10% 22NF	5322 122 32654
C2516	20% 470UF	5322 121 43887
C2517	20% 470UF	5322 121 43887
C2518	16V 20% 68UF	4822 124 11162
C2521	16V 20% 68UF	4822 124 11162
C2522	CAP 63V 10% 22NF	5322 122 32654
C2523	CAP 63V 10% 22NF	5322 122 32654
C2524	CAP 63V 10% 22NF	5322 122 32654
C2525	CAP 63V 10% 100NF	4822 130 33496
C2526	20% 470UF	5322 121 43885
C2527	CAP 63V 5% 680PF	5322 126 10733
C2528	CAP 100V 10% 100NF	5322 126 13186

Item	Description	Ordering code
C2530	16V 20% 68UF	4822 124 11162
C2531	CAP 63V 10% 220NF	4822 122 32916
C2532	16V 20% 68UF	4822 124 11162
C2533	CAP 63V 10% 2.2NF	4822 122 33127
C2534	CAP 63V 10% 22NF	5322 122 32654
C2535	CAP 100V 10% 100NF	5322 126 13186
C2536	20% 470UF	5322 121 43885
C2537	CAP 63V 10% 68NF	4822 122 32891
C2538	CAP 63V 10% 22NF	5322 122 32654
C2539	CAP 63V 10% 22NF	5322 122 32654
C2540	CAP 63V 10% 22NF	5322 122 32654
C2541	CAP 63V 10% 22NF	5322 122 32654
C2542	CAP 63V 10% 10NF	5322 122 34098
C2543	CAP 63V 10% 10NF	5322 122 34098
C2544	CAP 63V 5% 120PF	5322 122 33861
C2545	CAP 63V 10% 22NF	5322 122 32654
C2546	CAP 63V 10% 22NF	5322 122 32654
C2547	16V 20% 68UF	4822 124 11162
C2548	CAP 63V 10% 22NF	5322 122 32654
C2549	16V 20% 68UF	4822 124 11162
C2551	CAP 63V 10% 22NF	5322 122 32654
C2552	20% 3900UF	5322 124 42329
C2701	CAP 63V 10% 10NF	5322 122 34098
C2703	CAP 63V 10% 10NF	5322 122 34098
C2706	CAP 63V 5% 10PF	5322 122 32448
C2707	CAP 63V 10% 22NF	5322 122 32654
C2750	3KV 10% 22PF	5322 126 13331
C2752	CAP 63V 10% 22NF	5322 122 32654
C2753	CAP 63V 10% 2.2NF	4822 122 33127
C2754	CAP 63V 10% 2.2NF	4822 122 33127
C2756	CAP 63V 10% 22NF	5322 122 32654
C2757	CAP 63V 10% 2.2NF	4822 122 33127
C2758	CAP 63V 10% 2.2NF	4822 122 33127
C2759	CAP 63V 10% 2.2NF	4822 122 33127
C2760	CAP 63V 10% 2.2NF	4822 122 33127
C2761	CAP 63V 10% 2.2NF	4822 122 33127
C2762	CAP 63V 10% 2.2NF	4822 122 33127
C2763	CAP 63V 10% 2.2NF	4822 122 33127
C2804	CAP 63V 10% 10NF	5322 122 34098
C2806	CAP 63V 10% 10NF	5322 122 34098
C2850	CAP 63V 5% 3.3NF	5322 122 33897
C2851	CAP 63V 5% 3.3NF	5322 122 33897
C2852	CAP 63V 5% 3.3NF	5322 122 33897
C2853	CAP 63V 5% 2.2NF	5322 126 13457
C2854	CAP 63V 5% 680PF	5322 126 10733
C2856	CAP 63V 5% 270PF	4822 122 33216
C2857	CAP 63V 5% 47PF	5322 122 32452
C2861	CAP 63V 10% 10NF	5322 122 34098
C2862	CAP 63V 10% 10NF	5322 122 34098
C2863	CAP 63V 5% 47PF	5322 122 32452

Item	Description	Ordering code
C2864	CAP 63V 10% 10NF	5322 122 34098
C2866	CAP 63V 10% 2.2NF	4822 122 33127
C2867	CAP 63V 10% 2.2NF	4822 122 33127
C2868	CAP 63V 10% 2.2NF	4822 122 33127
C2901	CAP 63V 10% 10NF	5322 122 34098
DIGITAL INTEGRATED CIRCUITS		
D2101	74HC4316D PEL	4822 209 63764
D2102	74HC4316D PEL	4822 209 63764
D2201	74HC4316D PEL	4822 209 63764
D2202	74HC4316D PEL	4822 209 63764
D2302	OQ00259	5322 209 90317
D2750	74HC4316D PEL	4822 209 63764
D2751	74HC4316D PEL	4822 209 63764
D2850	74HC4316D PEL	4822 209 63764
D2901	74HC541D PEL	4822 209 63763
D2902	74HC541D PEL	4822 209 63763
D2903	74HC541D PEL	4822 209 63763
D2904	74HC4094D PEL	5322 209 12171
D2906	74HC4094D PEL	5322 209 12171
D2907	74HC4094D PEL	5322 209 12171
D2908	74HC4094D PEL	5322 209 12171
D2909	74HC4094D PEL	5322 209 12171
BUZZER		
H2901	-12B-12	5322 280 10245
RELAYS		
K2101	S RAL3W-K	5322 280 80745
K2102	S RAL3W-K	5322 280 80745
K2103	S RAL3W-K	5322 280 80745
K2201	S RAL3W-K	5322 280 80745
K2202	S RAL3W-K	5322 280 80745
K2203	S RAL3W-K	5322 280 80745
K2750	S RAL3W-K	5322 280 80745
K2751	S RAL3W-K	5322 280 80745
COILS		
L2500	15µH	4822 157 53066
L2501	1µH 5% TDK	5322 157 63648
L2502	68µH TDK	5322 157 63092
L2503	68µH TDK	5322 157 63092
L2504	22µH TDK	5322 157 52707
L2505	15µH	4822 157 53066
L2506	22µH TDK	5322 157 52707

Item	Description	Ordering code
ANALOG INTEGRATED CIRCUITS		
N2101	LF453CM NSC	4822 209 63757
N2201	LF453CM NSC	4822 209 63757
N2302	TDA8703T/C4 PEL	5322 209 30676
N2501	LM358M NSC	5322 209 82941
N2502	LM285M-1.2 NSC	4822 209 63765
N2503	SG3524D PEL	5322 209 71807
N2750	TLC27M2A CDR	5322 209 31309
N2751	TLC27M2A CDR	5322 209 31309
N2850	AMP LF453CM NSC	4822 209 63757
RESISTORS		
R2101	D25 1% 26E1	5322 117 12068
R2103	CHIP RC-02H 1% 100K	4822 051 10104
R2104	D25 1% 21E5	5322 117 11734
R2105	D25 1% 21E5	5322 117 11734
R2106	D25 1% 68E1	5322 117 11739
R2107	D25 1% 38E8	5322 117 11735
R2108	D25 1% 75E0	5322 117 11741
R2109	D25 1% 34E8	5322 117 11735
R2110	D25 1% 21E5	5322 117 11734
R2111	CHIP RC-02H 1% 3K83	5322 117 10561
R2112	CHIP RC-01 5% 10M	4822 051 10106
R2113	CHIP RC-01 5% 10M	4822 051 10106
R2114	CHIP RC-01 5% 10M	4822 051 10106
R2115	CHIP RC-02H 1% 1K33	4822 051 51332
R2116	D25 1% 75E	5322 117 11741
R2117	D25 1% 51E1	5322 117 11737
R2118	CHIP RC-02H 1% 34K8	5322 117 10558
R2119	ST MRS25 1% 953K	4822 050 29534
R2120	CHIP RC-01 5% 10M	4822 051 10106
R2121	CHIP RC-02H 1% 1M	4822 051 10105
R2122	CHIP RC-02H 1% 10K	4822 051 10103
R2123	CHIP RC-02H 1% 1M	4822 051 10105
R2124	D25 1% 51E1	5322 117 11737
R2125	CHIP RC-02H 1% 19K6	5322 117 10541
R2126	CHIP RC-02H 1% 100K	4822 051 10104
R2127	CHIP RC-02H 1% 11K	4822 051 10113
R2128	CHIP RC-02H 1% 1M	4822 051 10105
R2129	CHIP RC-02H 1% 681E	5322 117 10579
R2130	CHIP RC-02H 1% 100K	4822 051 10104
R2131	CHIP RC-02H 1% 147K	4822 051 51474
R2132	CHIP RC-02H 1% 75K	5322 117 10584
R2133	CHIP RC-02H 1% 3K83	5322 117 10561
R2134	CHIP RC-02H 1% 7K5	5322 117 10583
R2135	D25 1% 51E1	5322 117 11737
R2136	CHIP RC-02H 1% 750E	5322 117 10582

Item	Description	Ordering code
R2137	CHIP RC-02H 1% 215K	5322 117 10543
R2138	CHIP RC-02H 1% 1K	4822 051 10102
R2139	CHIP RC-02H 1% 10K	4822 051 10103
R2140	D25 1% 51E1	5322 117 11737
R2141	CHIP RC-02H 1% 10K	4822 051 10103
R2142	CHIP RC-02H 1% 178E	4822 051 51781
R2143	CHIP RC-02H 1% 3K48	5322 117 10557
R2144	CHIP RC-02H 1% 121E	4822 051 51211
R2145	CHIP RC-02H 1% 3K83	5322 117 10561
R2146	CHIP RC-02H 1% 3K83	5322 117 10561
R2147	RC-02H 1% 121K	4822 051 51214
R2148	CHIP RC-02H 1% 464K	5322 117 10568
R2149	D25 1% 51E1	5322 117 11737
R2150	D25 1% 10E	5322 117 11733
R2151	CHIP RC-02H 1% 61K9	5322 117 10578
R2152	CHIP RC-02H 1% 75K	5322 117 10584
R2153	CHIP RC-02H 1% 75K	5322 117 10584
R2154	CHIP RC-02H 1% 10K	4822 051 10103
R2155	CHIP RC-02H 1% 1M	4822 051 10105
R2156	DISK 600V 1K1	5322 116 40232
R2157	CHIP RC-02H 1% 31K6	5322 117 10554
R2158	CHIP RC-02H 1% 51K1	4822 051 55113
R2159	CHIP RC-02H 1% 100K	4822 051 10104
R2160	CHIP RC-02H 1% 511E	5322 117 10569
R2161	CHIP RC-02H 1% 2K15	5322 117 10485
R2162	CHIP RC-02H 1% 215K	5322 117 10543
R2163	CHIP RC-02H 1% 464K	5322 117 10568
R2164	CHIP RC-02H 1% 825K	5322 117 10587
R2165	RC-02H 1% 21K5	5322 117 10542
R2166	D25 1% 68E1	5322 117 11739
R2167	CHIP RC-02H 1% 1M	4822 051 10105
R2168	CHIP RC-02H 1% 11K	4822 051 10113
R2169	CHIP RC-02H 1% 31K6	5322 117 10554
R2170	CHIP RC-02H 1% 3K83	5322 117 10561
R2171	CHIP RC-02H 1% 100E	4822 051 10101
R2172	CHIP RC-02H 1% 2K15	5322 117 10485
R2175	CHIP RC-02H 1% 383K	5322 117 10563
R2176	DISK 600V 1K1	5322 116 40232
R2177	D25 1% 21E5	5322 117 11734
R2201	D25 1% 23E7	5322 117 11975
R2203	CHIP RC-02H 1% 100K	4822 051 10104
R2204	D25 1% 21E5	5322 117 11734
R2205	D25 1% 21E5	5322 117 11734
R2206	D25 1% 68E1	5322 117 11739
R2207	D25 1% 31E6	5322 117 11732
R2208	D25 1% 75E0	5322 117 11741
R2209	D25 1% 34E8	5322 117 11735
R2210	D25 1% 21E5	5322 117 11734

Item	Description	Ordering code
R2211	CHIP RC-02H 1% 3K83	5322 117 10561
R2212	CHIP RC-01 5% 10M	4822 051 10106
R2213	CHIP RC-01 5% 10M	4822 051 10106
R2214	CHIP RC-01 5% 10M	4822 051 10106
R2215	CHIP RC-02H 1% 1K33	4822 051 51332
R2216	D25 1% 75E	5322 117 11741
R2217	D25 1% 51E1	5322 117 11737
R2218	CHIP RC-02H 1% 34K8	5322 117 10558
R2219	ST MRS25 1% 953K	4822 050 29534
R2220	CHIP RC-01 5% 10M	4822 051 10106
R2221	CHIP RC-02H 1% 1M	4822 051 10105
R2222	CHIP RC-02H 1% 10K	4822 051 10103
R2223	CHIP RC-02H 1% 1M	4822 051 10105
R2224	D25 1% 51E1	5322 117 11737
R2225	CHIP RC-02H 1% 19K6	5322 117 10541
R2226	CHIP RC-02H 1% 100K	4822 051 10104
R2227	CHIP RC-02H 1% 11K	4822 051 10113
R2228	CHIP RC-02H 1% 1M	4822 051 10105
R2229	CHIP RC-02H 1% 681E	5322 117 10579
R2230	CHIP RC-02H 1% 100K	4822 051 10104
R2231	CHIP RC-02H 1% 147K	4822 051 51474
R2232	CHIP RC-02H 1% 75K	5322 117 10584
R2233	CHIP RC-02H 1% 3K83	5322 117 10561
R2234	CHIP RC-02H 1% 7K5	5322 117 10583
R2235	D25 1% 51E1	5322 117 11737
R2236	CHIP RC-02H 1% 750E	5322 117 10582
R2237	CHIP RC-02H 1% 215K	5322 117 10543
R2238	CHIP RC-02H 1% 1K	4822 051 10102
R2239	CHIP RC-02H 1% 10K	4822 051 10103
R2240	D25 1% 51E1	5322 117 11737
R2241	RC-02H 1% 10K	4822 051 10103
R2242	RC-02H 1% 178E	4822 051 51781
R2243	RC-02H 1% 3K48	5322 117 10557
R2244	RC-02H 1% 121E	4822 051 51211
R2245	RC-02H 1% 3K83	5322 117 10561
R2246	RC-02H 1% 3K83	5322 117 10561
R2247	RC-02H 1% 121K	4822 051 51214
R2248	RC-02H 1% 464K	5322 117 10568
R2249	D25 1% 51E1	5322 117 11737
R2250	D25 1% 10E	5322 117 11733
R2250	D25 1% 10E	5322 117 11733
R2251	RC-02H 1% 61K9	5322 117 10578
R2252	RC-02H 1% 75K	5322 117 10584
R2253	RC-02H 1% 75K	5322 117 10584
R2254	RC-02H 1% 10K	4822 051 10103
R2255	RC-02H 1% 1M	4822 051 10105
R2256	DISK 600V 1K1	5322 116 40232
R2257	RC-02H 1% 31K6	5322 117 10554
R2258	RC-02H 1% 51K1	4822 051 55113

Item	Description	Ordering code
R2259	RC-02H 1% 100K	4822 051 10104
R2260	RC-02H 1% 511E	5322 117 10569
R2261	RC-02H 1% 2K15	5322 117 10485
R2262	RC-02H 1% 215K	5322 117 10543
R2263	RC-02H 1% 464K	5322 117 10568
R2264	RC-02H 1% 825K	5322 117 10587
R2265	RC-02H 1% 21K5	5322 117 10542
R2266	D25 1% 68E1	5322 117 11739
R2267	RC-02H 1% 1M	4822 051 10105
R2268	RC-02H 1% 11K	4822 051 10113
R2269	RC-02H 1% 31K6	5322 117 10554
R2270	RC-02H 1% 3K83	5322 117 10561
R2271	RC-02H 1% 100E	4822 051 10101
R2272	RC-02H 1% 2K15	5322 117 10485
R2275	RC-02H 1% 383K	5322 117 10563
R2276	DISK 600V 1K1	5322 116 40232
R2277	D25 1% 21E5	5322 117 11734
R2299	RC-02H 1% 3K16	5322 117 10553
R2301	RC-01 5% 1E	4822 051 10108
R2302	RC-01 5% 1E	4822 051 10108
R2303	RC-02H 1% 1K33	4822 051 51332
R2304	RC-02H 1% 511K	5322 117 10571
R2305	RC-01 5% 1E	4822 051 10108
R2306	RC-01 5% 1E	4822 051 10108
R2307	RC-01 5% 1E	4822 051 10108
R2308	RC-02H 1% 75K	5322 117 10584
R2309	RC-02H 1% 75K	5322 117 10584
R2310	RC-02H 1% 1K62	4822 051 51622
R2311	RC-02H 1% 196E	5322 117 10538
R2313	CHIP RC-01 5% 1E	4822 051 10108
R2315	CHIP RC-02H 1% 100E	4822 051 10101
R2316	CHIP RC-02H 1% 100K	4822 051 10104
R2317	CHIP RC-02H 1% 100K	4822 051 10104
R2319	D25 1% 31E6	5322 117 11732
R2320	RC-02H 1% 75K0	5322 117 10584
R2321	CHIP RC-02H 1% 316K	5322 117 10555
R2322	CHIP RC-02H 1% 31K6	5322 117 10554
R2323	RC-02H 1% 1K00	4822 051 10102
R2324	RC-02H 1% 3K16	5322 117 10553
R2326	RC-02H 1% 1K62	4822 051 51622
R2327	RC-02H 1% 100E	4822 051 10101
R2328	RC-02H 1% 100E	4822 051 10101
R2330	RC-02H 1% 178E	4822 051 51781
R2331	RC-02H 1% 178E	4822 051 51781
R2332	RC-02H 1% 178E	4822 051 51781
R2333	RC-02H 1% 178E	4822 051 51781
R2334	RC-02H 1% 178E	4822 051 51781
R2335	RC-02H 1% 178E	4822 051 51781
R2336	RC-02H 1% 178E	4822 051 51781

Item	Description	Ordering code
R2337	RC-02H 1% 178E	4822 051 51781
R2345	RC-02H 1% 100K	4822 051 10104
R2346	OTM RVG4 25% 10K	5322 100 12194
R2347	OTM RVG4 25% 10K	5322 100 12194
R2350	RC-02H 1% 162E	4822 051 51621
R2351	RC-02H 1% 147K	4822 051 51474
R2352	D25 1% 31E6	5322 117 11732
R2353	RC-02H 1% 1K78	4822 051 51782
R2354	RC-02H 1% 1K00	4822 051 10102
R2355	D25 1% 75E	5322 117 11741
R2356	RC-02H 1% 511E	5322 117 10569
R2357	RC-02H 1% 100E	4822 051 10101
R2358	D25 1% 68E1	5322 117 11739
R2359	RC-02H 1% 3K48	5322 117 10557
R2360	RC-02H 1% 3K83	5322 117 10561
R2361	CHIP RC-02H 1% 511E	5322 117 10569
R2362	RC-02H 1% 3K83	5322 117 10561
R2363	CHIP RC-02H 1% 511E	5322 117 10569
R2364	RC-02H 1% 1K10	4822 051 51102
R2501	CHIP RC-02H 1% 511E	5322 117 10569
R2502	CHIP RC-02H 1% 511E	5322 117 10569
R2503	CHIP RC-01 5% 1E	4822 051 10108
R2504	CHIP RC-02H 1% 11K	4822 051 10113
R2506	D25 1% 10E	5322 117 11733
R2507	CHIP RC-02H 1% 147Ω	4822 051 51471
R2508	D25 1% 51E1	5322 117 11737
R2509	CHIP RC-01 5% 1E	4822 051 10108
R2511	CHIP RC-01 5% 1E	4822 051 10108
R2512	CHIP RC-01 5% 1E	4822 051 10108
R2513	CHIP RC-01 5% 1E	4822 051 10108
R2514	CHIP RC-01 5% 1E	4822 051 10108
R2516	CHIP RC-01 5% 1E	4822 051 10108
R2517	CHIP RC-01 5% 1E	4822 051 10108
R2518	CHIP RC-01 5% 1E	4822 051 10108
R2519	CHIP RC-01 5% 10M	4822 051 10106
R2521	CHIP RC-01 5% 10M	4822 051 10106
R2522	CHIP RC-02H 1% 11K	4822 051 10113
R2523	RC-02H 1% 3K48	5322 117 10557
R2524	RC-02H 1% 121E	4822 051 51211
R2526	CHIP RC-02H 1% 34K8	5322 117 10558
R2527	CHIP RC-02H 1% 2K15	5322 117 10485
R2528	CHIP RC-02H 1% 11K	4822 051 10113
R2529	CHIP RC-02H 1% 121E	4822 051 51211
R2530	CHIP RC-02H 1% 5K11	5322 117 10487
R2531	CHIP RC-01 5% 1E	4822 051 10108
R2532	D25 1% 10E	5322 117 11733
R2534	CHIP RC-02H 1% 19K6	5322 117 10541
R2535	CHIP RC-02H 1% 51K1	4822 051 55113
R2536	CHIP RC-02H 1% 1K	4822 051 10102
R2537	CHIP RC-02H 1% 34K8	5322 117 10558

Item	Description	Ordering code
R2538	CHIP RC-02H 1% 3K16	5322 117 10553
R2540	CHIP RC-02H 1% 3K16	5322 117 10553
R2541	CHIP RC-02H 1% 11K	4822 051 10113
R2542	D25 1% 10E	5322 117 11733
R2543	CHIP RC-02H 1% 5K11	5322 117 10487
R2544	CHIP RC-02H 1% 34K8	5322 117 10558
R2546	CHIP RC-02H 1% 121E	4822 051 51211
R2548	CHIP RC-02H 1% 14K7	4822 051 51473
R2551	CHIP RC-02H 1% 11K	4822 051 10113
R2554	CHIP RC-02H 1% 1K33	4822 051 51332
R2556	CHIP RC-02H 1% 5K62	5322 117 10573
R2557	CHIP RC-02H 1% 2K15	5322 117 10485
R2558	CHIP RC-02H 1% 2K15	5322 117 10485
R2559	CHIP RC-02H 1% 2K15	5322 117 10485
R2561	CHIP RC-02H 1% 215K	5322 117 10543
R2562	CHIP RC-02H 1% 11K	4822 051 10113
R2563	RC-01 5% 2E2	4822 051 10228
R2563	RC-01 5% 2E2	4822 051 10228
R2564	CHIP RC-02H 1% 7K5	5322 117 10583
R2565	D25 1% 51E1	5322 117 11737
R2566	CHIP RC-02H 1% 34K8	5322 117 10558
R2567	CHIP RC-02H 1% 34K8	5322 117 10558
R2568	CHIP RC-02H 1% 215K	5322 117 10543
R2569	CHIP RC-02H 1% 215K	5322 117 10543
R2571	CHIP RC-01 5% 1E	4822 051 10108
R2572	CHIP RC-02H 1% 100K	4822 051 10104
R2573	CHIP RC-02H 1% 215K	5322 117 10543
R2575	CHIP RC-02H 1% 51K1	4822 051 55113
R2580	LRC01 5% 0E1	5322 117 11759
R2581	CHIP RC-02H 1% 100K	4822 051 10104
R2583	CHIP RC-01 5% 1E	4822 051 10108
R2584	D25 1% 10E	5322 117 11733
R2596	CHIP RC-02H 1% 19K6	5322 117 10541
R2597	CHIP RC-02H 1% 19K6	5322 117 10541
R2598	CHIP RC-02H 1% 100K	4822 051 10104
R2599	CHIP RC-02H 1% 19K6	5322 117 10541
R2729	CHIP RC-02H 1% 61K9	5322 117 10578
R2750	DISC SPEC	5322 116 40214
R2753	RST VR25 487K 1%	5322 116 82905
R2754	CHIP RC-02H 1% 511K	5322 117 10571
R2755	CHIP RC-02H 1% 1K	4822 051 10102
R2757	CHIP RC-02H 1% 34K8	5322 117 10558
R2758	CHIP RC-02H 1% 10K	4822 051 10103
R2759	CHIP RC-02H 1% 261E	4822 051 52611
R2760	D25 1% 68E1	5322 117 11739
R2761	CHIP RC-02H 1% 215K	5322 117 10543
R2762	CHIP RC-02H 1% 1M	4822 051 10105
R2763	CHIP RC-01 5% 10M	4822 051 10106
R2764	CHIP RC-02H 1% 68K1	4822 051 56813
R2765	CHIP RC-02H 1% 10K	4822 051 10103

Item	Description	Ordering code
R2766	CHIP RC-02H 1% 19K6	5322 117 10541
R2767	CHIP RC-02H 1% 5K11	5322 117 10487
R2768	CHIP RC-02H 1% 237K	5322 117 11742
R2769	CHIP RC-02H 1% 147K	4822 051 51474
R2770	CHIP RC-02H 1% 34K8	5322 117 10558
R2771	CHIP RC-02H 1% 100K	4822 051 10104
R2772	CHIP RC-02H 1% 100K	4822 051 10104
R2773	CHIP RC-02H 1% 1K	4822 051 10102
R2774	CHIP RC-02H 1% 1K	4822 051 10102
R2775	CHIP RC-02H 1% 3K48	5322 117 10557
R2776	CHIP RC-02H 1% 34K8	5322 117 10558
R2777	D25 1% 51E1	5322 117 11737
R2778	RST VR25 487K 1%	5322 116 82905
R2853	CHIP RC-02H 1% 31K6	5322 117 10554
R2854	CHIP RC-02H 1% 31K6	5322 117 10554
R2856	CHIP RC-02H 1% 68K1	4822 051 56813
R2857	CHIP RC-02H 1% 68K1	4822 051 56813
R2858	CHIP RC-02H 1% 2K15	5322 117 10485
R2859	CHIP RC-02H 1% 75K	5322 117 10584
R2860	CHIP RC-01 5% 10M	4822 051 10106
R2861	CHIP RC-02H 1% 237K	5322 117 11742
R2862	CHIP RC-02H 1% 562K	5322 117 10575
R2863	CHIP RC-02H 1% 3K48	5322 117 10557
R2864	CHIP RC-02H 1% 34K8	5322 117 10558
R2865	CHIP RC-02H 1% 34K8	5322 117 10558
R2866	CHIP RC-02H 1% 121E	4822 051 51211
R2867	CHIP RC-02H 1% 34K8	5322 117 10558
R2868	CHIP RC-02H 1% 34K8	5322 117 10558
R2869	CHIP RC-02H 1% 34K8	5322 117 10558
R2870	CHIP RC-02H 1% 261K	5322 117 10853
R2871	CHIP RC-02H 1% 464K	5322 117 10568
R2872	CHIP RC-02H 1% 464K	5322 117 10568
R2873	CHIP RC-02H 1% 261K	5322 117 10853
R2875	CHIP RC-02H 1% 215K	5322 117 10543
R2876	CHIP RC-02H 1% 316K	5322 117 10555
R2877	CHIP RC-02H 1% 215K	5322 117 10543
R2878	CHIP RC-02H 1% 51K1	4822 051 55113
R2879	CHIP RC-02H 1% 19K6	5322 117 10541
R2881	CHIP RC-02H 1% 261E	4822 051 52611
R2901	CHIP RC-02H 1% 19K6	5322 117 10541
R2903	CHIP RC-02H 1% 147K	4822 051 51474
R2904	CHIP RC-02H 1% 31K6	5322 117 10554
R2906	CHIP RC-02H 1% 31K6	5322 117 10554
R2907	CHIP RC-02H 1% 34K8	5322 117 10558
R2908	CHIP RC-02H 1% 31K6	5322 117 10554
R2909	CHIP RC-02H 1% 31K6	5322 117 10554

TRAFO

T2501	TRAFO	5322 146 21674

Item	Description	Ordering code
DIODES/TRANSISTORS		
V2104	BFR92A PEL	5322 130 60647
V2105	BFR31 PEL	5322 130 44787
V2106	BFR92A PEL	5322 130 60647
V2107	BF991 PEL	5322 130 61707
V2108	BFS20 PEL	5322 130 42718
V2109	BFR92A PEL	5322 130 60647
V2110	BC848C PEL	5322 130 42136
V2111	BFR92A PEL	5322 130 60647
V2112	BC848C PEL	5322 130 42136
V2113	BC848C PEL	5322 130 42136
V2114	BFR92A PEL	5322 130 60647
V2204	BFR92A PEL	5322 130 60647
V2205	BFR31 PEL	5322 130 44787
V2206	BFR92A PEL	5322 130 60647
V2207	BF991 PEL	5322 130 61707
V2208	BFS20 PEL	5322 130 42718
V2209	BFR92A PEL	5322 130 60647
V2210	BC848C PEL	5322 130 42136
V2211	BFR92A PEL	5322 130 60647
V2212	BC848C PEL	5322 130 42136
V2213	BC848C PEL	5322 130 42136
V2214	BFR92A PEL	5322 130 60647
V2304	BC848C PEL	5322 130 42136
V2305	BFR92A PEL	5322 130 60647
V2306	BFR92A PEL	5322 130 60647
V2307	BFR92A PEL	5322 130 60647
V2501	BAV99 PEL	5322 130 34337
V2502	BRY62 PEL	5322 130 62661
V2503	FET BUZ11A SIE	5322 130 62659
V2504	BAV99 PEL	5322 130 34337
V2505	RECT.DIODE BYD77A	5322 130 10763
V2506	MBRD630CTT4 MOT	5322 130 62922
V2507	MBRD630CTT4 MOT	5322 130 62922
V2508	BAV99 PEL	5322 130 34337
V2509	BC848C PEL	5322 130 42136
V2511	BC858C PEL	4822 130 42513
V2512	BAV99 PEL	5322 130 34337
V2513	BC858C PEL	4822 130 42513
V2514	BAV99 PEL	5322 130 34337
V2516	BC858C PEL	4822 130 42513
V2517	BC848C PEL	5322 130 42136
V2518	BF821 PEL	4822 130 61923
V2521	BC848C PEL	5322 130 42136
V2523	BAV99 PEL	5322 130 34337
V2526	BC817 PEL	4822 130 42133
V2527	BAV99 PEL	5322 130 34337
V2528	BC848C PEL	5322 130 42136
V2529	BAV99 PEL	5322 130 34337

Item	Description	Ordering code
V2532	FET BUZ11A SIE	5322 130 62659
V2533	MBRD630CTT4 MOT	5322 130 62922
V2534	BC848C PEL	5322 130 42136
V2536	BC848C PEL	5322 130 42136
V2537	FET 2SK974STR HIT	5322 130 62921
V2538	FET 2SK974STR HIT	5322 130 62921
V2539	MBRD630CTT4 MOT	5322 130 62922
V2540	BC848C PEL	5322 130 42136
V2541	BC848C PEL	5322 130 42136
V2542	FET BUZ11A SIE	5322 130 62659
V2543	BC848C PEL	5322 130 42136
V2544	BC858C PEL	4822 130 42513
V2550	BAV99 PEL	5322 130 34337
V2736	BC858C PEL	4822 130 42513
V2751	BZD27-C7V5L	4822 130 82522
V2752	BZD27-C7V5L	4822 130 82522
V2753	BZD27-C7V5L	4822 130 82522
V2754	BFR31 PEL	5322 130 44787
V2755	BZD27-C7V5L	4822 130 82522
V2756	BFR31 PEL	5322 130 44787
V2757	BAV99 PEL	5322 130 34337
V2758	SFET BSS83 PEL	5322 130 60502
V2759	BAV99 PEL	5322 130 34337
V2760	BC848C PEL	5322 130 42136
V2761	BC848C PEL	5322 130 42136
V2762	BAV99 PEL	5322 130 34337
V2763	BAV99 PEL	5322 130 34337
V2764	BZD27-C7V5L	4822 130 82522
V2767	BC848C PEL	5322 130 42136
V2768	BC848C PEL	5322 130 42136
V2769	BZD27-C7V5L	4822 130 82522
V2811	BZD27-C7V5L	4822 130 82522
V2812	BZD27-C7V5L	4822 130 82522
V2851	SFET BSS83 PEL	5322 130 60502
V2852	BC858C PEL	4822 130 42513
V2853	BC858C PEL	4822 130 42513
V2854	BC858C PEL	4822 130 42513
V2901	BC858C PEL	4822 130 42513

CONNECTORS

X2001	30-P 1.25 MM RECHT	5322 267 70302
X2501	ACK HEC0739-01-010	4822 267 30431
X2502	3-P MKS 37	5322 265 10965
X2701	5P SNG 1.5	5322 265 10396
X2901	5P SNG 1.5	5322 265 10396

EMI-FILTER

Z2501	50V 10A MUR	5322 156 11139

Table 8.6 TV Trigger A3 PCB assembly (Figure 8.7)

When servicing the ScopeMeter® test tool, use only the replacement parts specified.

Item	Figure	Description	Ordering code	Qty
A3	8.7	TV Trigger A3 PCB assembly	5322 216 04012	1

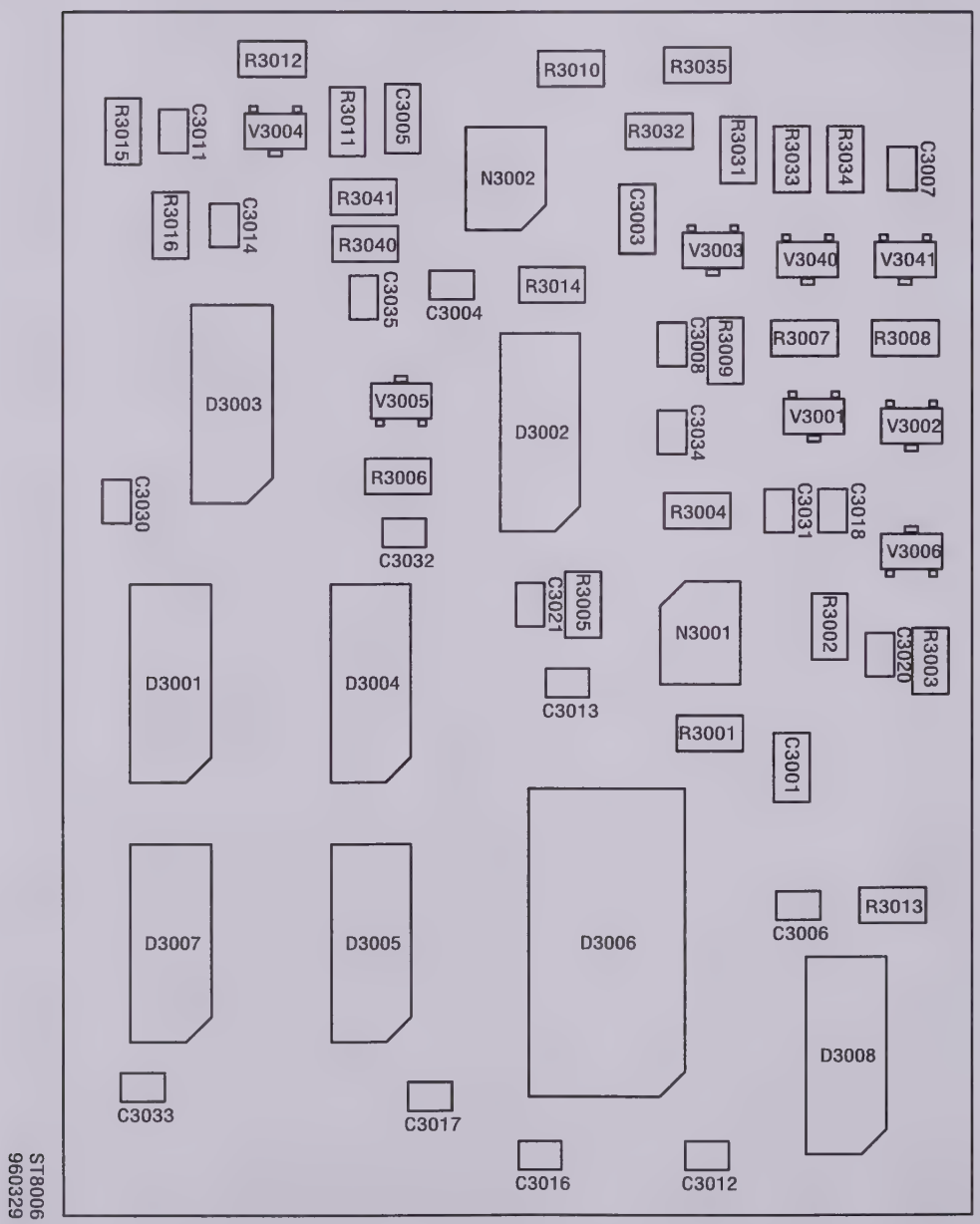


Figure 8.6 TV Trigger A3 PCB assembly.

Item	Description	Ordering code
A3 BOARD		
CAPACITORS		
C3001	63V 10% 100NF	4822 122 33496
C3002	25V -10+50% 6.8UF	5322 124 11509
C3003	63V 10% 100NF	4822 122 33496
C3004	63V 10% 22NF	4822 122 33893
C3005	63V 10% 100NF	4822 122 33496
C3006	63V 5% 220PF	4822 122 33575
C3007	63V 10% 22NF	4822 122 33893
C3008	63V 10% 22NF	4822 122 33893
C3011	63V 10% 22NF	4822 122 33893
C3012	63V 10% 22NF	4822 122 33893
C3013	63V 10% 22NF	4822 122 33893
C3014	63V 10% 22NF	4822 122 33893
C3016	63V 10% 22NF	4822 122 33893
C3017	63V 10% 22NF	4822 122 33893
C3018	63V 10% 22NF	4822 122 33893
C3020	63V 0.25PF 4.7PF	5322 122 32287
C3021	63V 0.25PF 4.7PF	5322 122 32287
C3030	63V 10% 22NF	5322 122 32654
C3031	63V 10% 22NF	5322 122 32654
C3032	63V 10% 22NF	5322 122 32654
C3033	63V 10% 22NF	5322 122 32654
C3034	63V 10% 22NF	5322 122 32654
C3035	63V 10% 22NF	5322 122 32654
DIGITAL INTEGRATED CIRCUITS		
D3001	74HCT112D	5322 209 11825
D3002	74HCT4053D	5322 209 60189
D3003	74HCT4053D	5322 209 60189
D3004	74HCT4094D	5322 209 12171
D3005	74HCT4094D	5322 209 12171
D3006	HEF4059BT	5322 209 11631
D3007	74HC4094D	5322 209 12171
D3008	74HCT112D	5322 209 11825
ANALOG INTEGRATED CIRCUITS		
N3001	TLE2082CD TI	5322 209 12943
N3002	LM1881M NSC	4822 209 60767

Item	Description	Ordering code
RESISTORS		
R3001	RC-02H 1% 287K	5322 117 12066
R3002	RC-02H 1% 3K16	5322 117 10553
R3003	RC-02H 1% 316E	5322 117 10552
R3004	RC-02H 1% 3K16	5322 117 10553
R3005	RC-02H 1% 3K16	5322 117 10553
R3006	RC-02H 1% 10K	4822 051 10103
R3007	RC-02H 1% 8K25	5322 117 10586
R3008	RC-02H 1% 3K16	5322 117 10553
R3009	RC-02H 1% 3K16	5322 117 10553
R3010	RC-02H 1% 681K	5322 117 10854
R3011	RC-02H 1% 287K	5322 117 12066
R3012	RC-02H 1% 21K5	5322 117 10542
R3013	RC-02H 1% 21K5	5322 117 10542
R3014	RC-02H 1% 1M	4822 051 10105
R3015	RC-01 5% 3E3	4822 051 10338
R3016	RC-01 5% 3E3	4822 051 10338
R3031	RC-02H 1% 3K16	5322 117 10553
R3032	RC-02H 1% 2K37	5322 117 10545
R3033	RC-02H 1% 237E	5322 117 10544
R3034	RC-02H 1% 237E	5322 117 10544
R3035	RC-02H 1% 3K16	5322 117 10553
R3040	RC-02H 1% 21K5	5322 117 10542
R3041	RC-02H 1% 21K5	5322 117 10542
DIODES/TRANSISTORS		
V3001	BC858C PEL	4822 130 42513
V3002	BC858C PEL	4822 130 42513
V3003	BC848C PEL	5322 130 42136
V3004	BC848C PEL	5322 130 42136
V3005	BAV99	5322 130 34337
V3006	BF556A	5322 130 10181
V3040	BC848C	5322 130 42136
V3041	BC848C	5322 130 42136

8.3 STANDARD KIT ACCESSORY REPLACEMENTS

DESCRIPTION	MODEL - ORDERING CODE	FIGURE	ITEM
Grey Holster	PM9083/011		
Yellow Holster	PM9083/001		
NiCad Battery Pack	PM9086/011		
Power Adapter/Battery Charger (four models available:)			
• Universal Europe 230V, 50 Hz	PM8907/801		
• North America 115V, 60 Hz	PM8907/803		
• United Kingdom 230V, 50 Hz	PM8907/804		
• Universal 115V/230V	PM8907/808 (North American line plug)		
• 100V (Japan)	PM8097/806		
Accessory Case, Soft	C 75		
Probe Set 10:1 probes	PM8918/002	Fig. 8.8	
• 10:1 Probe (Red)	5322 210 70139		Item 1
• 10:1 Probe (Grey)	5322 210 70138		Item 2
• HF Adapter (2 x Black)	5322 263 50193		Item 3
• Adapter Probe Tip to Banana (Red)	5322 264 20096		Item 4
• Adapter Probe Tip to Banana (Grey)	5322 264 20097		Item 5
• High Voltage Testpin (Red)	5322 264 20087		Item 6
• High Voltage Testpin (Grey)	5322 264 20088		Item 7
• Mini Test Hook (Red)	5322 210 70131		Item 8
• Mini Test Hook (Grey)	5322 210 70129		Item 9
• Trim Screwdriver (Red)	5322 395 50417		Item 10
• Trim Screwdriver (Grey)	5322 395 50416		Item 11
Industrial Alligator Clips (1 Red, 1 Grey)	PM9084/001	Fig. 8.10	
Multimeter Test Lead Set	5322 310 32086	Fig. 8.9	
• Test Leads (1 Red, 1 Black)	TL24		Item 1
• Test Pins (1 Red, 1 Black)	TP20		Item 2
• Industrial Alligator Clip (Black)	AC20		Item 3
• Banana Adapter (Red)	5322 264 20051		Item 4
• Banana Adapter (Black)	5322 264 20052		Item 5
Adapter Dual Banana Plug to BNC	PM9081/001	Fig. 8.11	
Product Software			
• SW90D FlukeView™ for DOS			
• SW90W FlukeView™ for Windows			
Probe Accessory set models 92, 96, 99 and 105	PM9094/001		
• Adapter Dual Banana Plug to BNC	PM9081/001	Fig. 8.11	
• HF Adapter (2 x Black)	5322 263 50193	Fig. 8.8	Item 3
• Adapter Probe Tip to Banana (Red)	5322 264 20096	Fig. 8.8	Item 4
• Adapter Probe Tip to Banana (Grey)	5322 264 20097	Fig. 8.8	Item 5
• High Voltage Testpin (Red)	5322 264 20087	Fig. 8.8	Item 6
• High Voltage Testpin (Grey)	5322 264 20088	Fig. 8.8	Item 7
• Mini Test Hook (Red)	5322 210 70131	Fig. 8.8	Item 8
• Mini Test Hook (Grey)	5322 210 70129	Fig. 8.8	Item 9
• Trim Screwdriver (Red)	5322 395 50417	Fig. 8.8	Item 10
• Trim Screwdriver (Grey)	5322 395 50416	Fig. 8.8	Item 11

Description	Ordering code
Demo board	5322 216 51279
User's Manual English	4822 872 00724
User's Manual German	4822 872 00725
User's Manual French	4822 872 00726
User's Manual Dutch	4822 872 00727
User's Manual Spanish	4822 872 00728
User's Manual Italian	4822 872 00729
User's Manual Finnish	4822 872 00731
User's Manual Norwegian	4822 872 00732
User's Manual Swedish	4822 872 00733
Manual Danish	4822 872 00734
User's Manual Japanese	4822 872 00735
User's Manual Korean	4822 872 00736
User's Manual Chinese	4822 872 00737

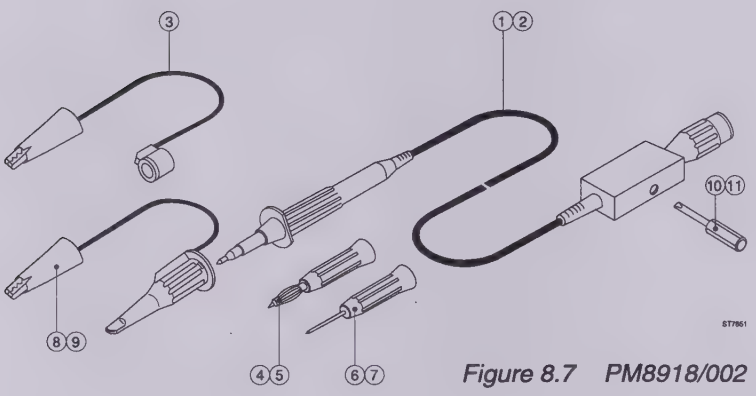


Figure 8.7 PM8918/002

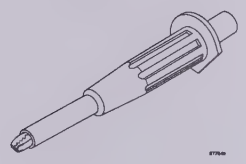


Figure 8.9 PM9084/001

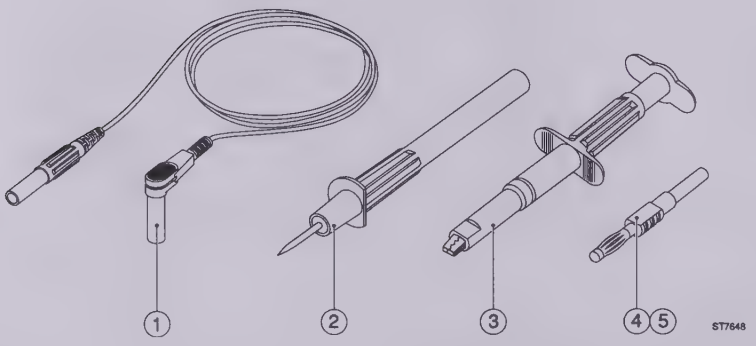


Figure 8.8 Multimeter Test Lead Set

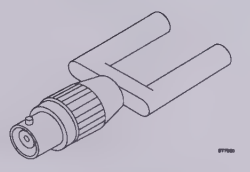


Figure 8.10 PM9081/001

9 CIRCUIT DIAGRAMS

This chapter contains all circuit diagrams and PCB layouts of both the ScopeMeter test tool analog and digital PCBs.
For newer versions also see Chapter 10 “Modifications”.

Description	Ordering code
Demo board	5322 216 51279
User's Manual English	4822 872 00724
User's Manual German	4822 872 00725
User's Manual French	4822 872 00726
User's Manual Dutch	4822 872 00727
User's Manual Spanish	4822 872 00728
User's Manual Italian	4822 872 00729
User's Manual Finnish	4822 872 00731
User's Manual Norwegian	4822 872 00732
User's Manual Swedish	4822 872 00733
Manual Danish	4822 872 00734
User's Manual Japanese	4822 872 00735
User's Manual Korean	4822 872 00736
User's Manual Chinese	4822 872 00737

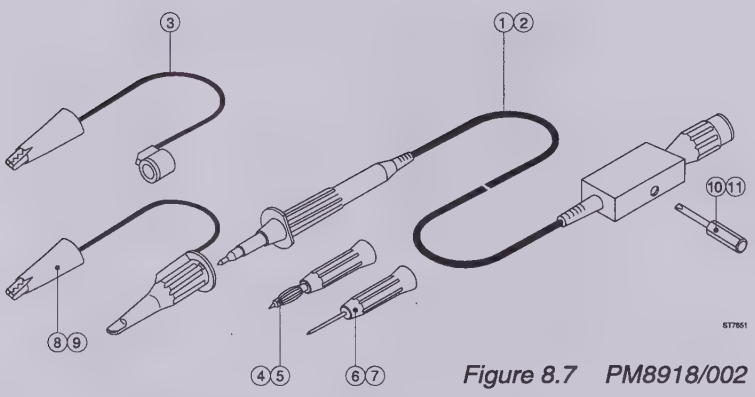


Figure 8.7 PM8918/002

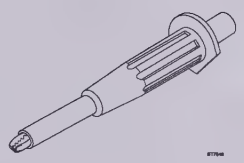


Figure 8.9 PM9084/001

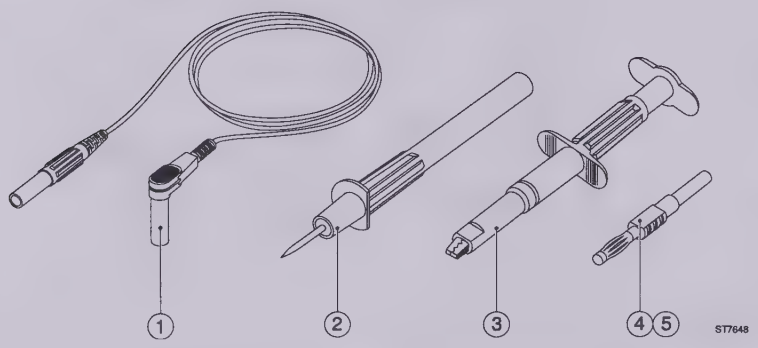


Figure 8.8 Multimeter Test Lead Set

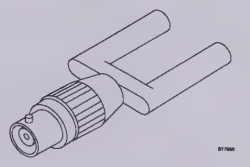


Figure 8.10 PM9081/001

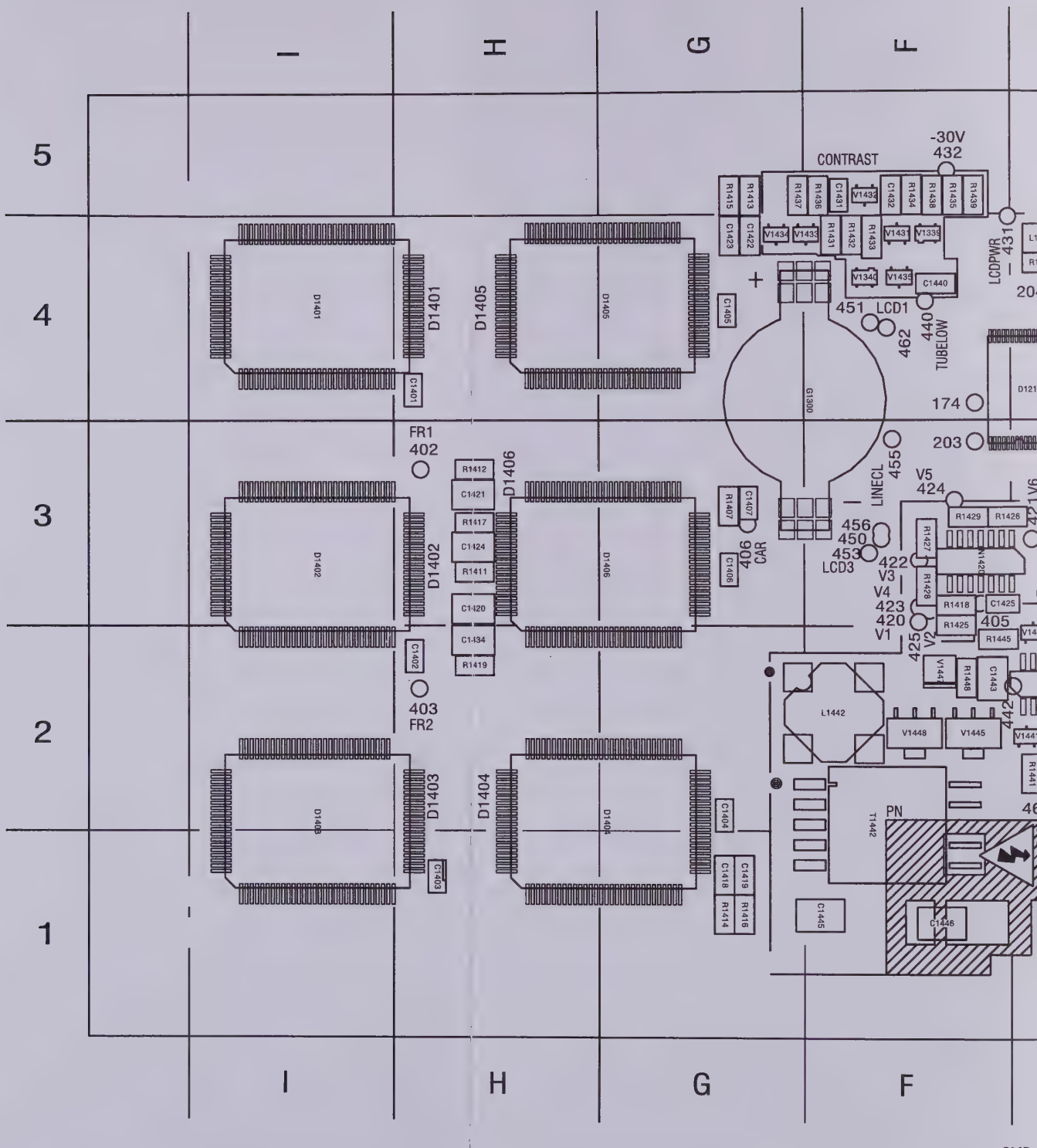


Figure 9.11 Digital A1 PCB

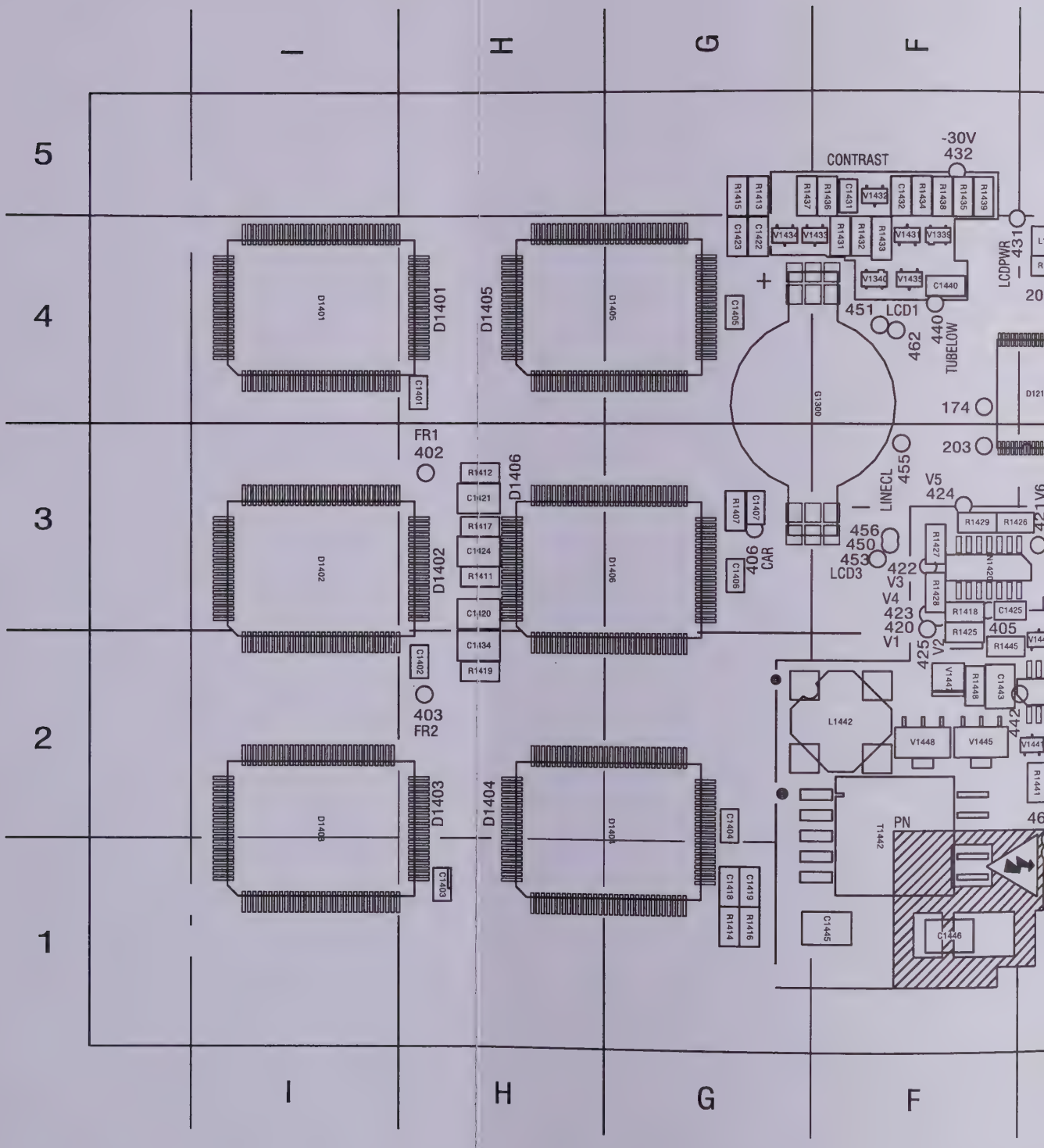
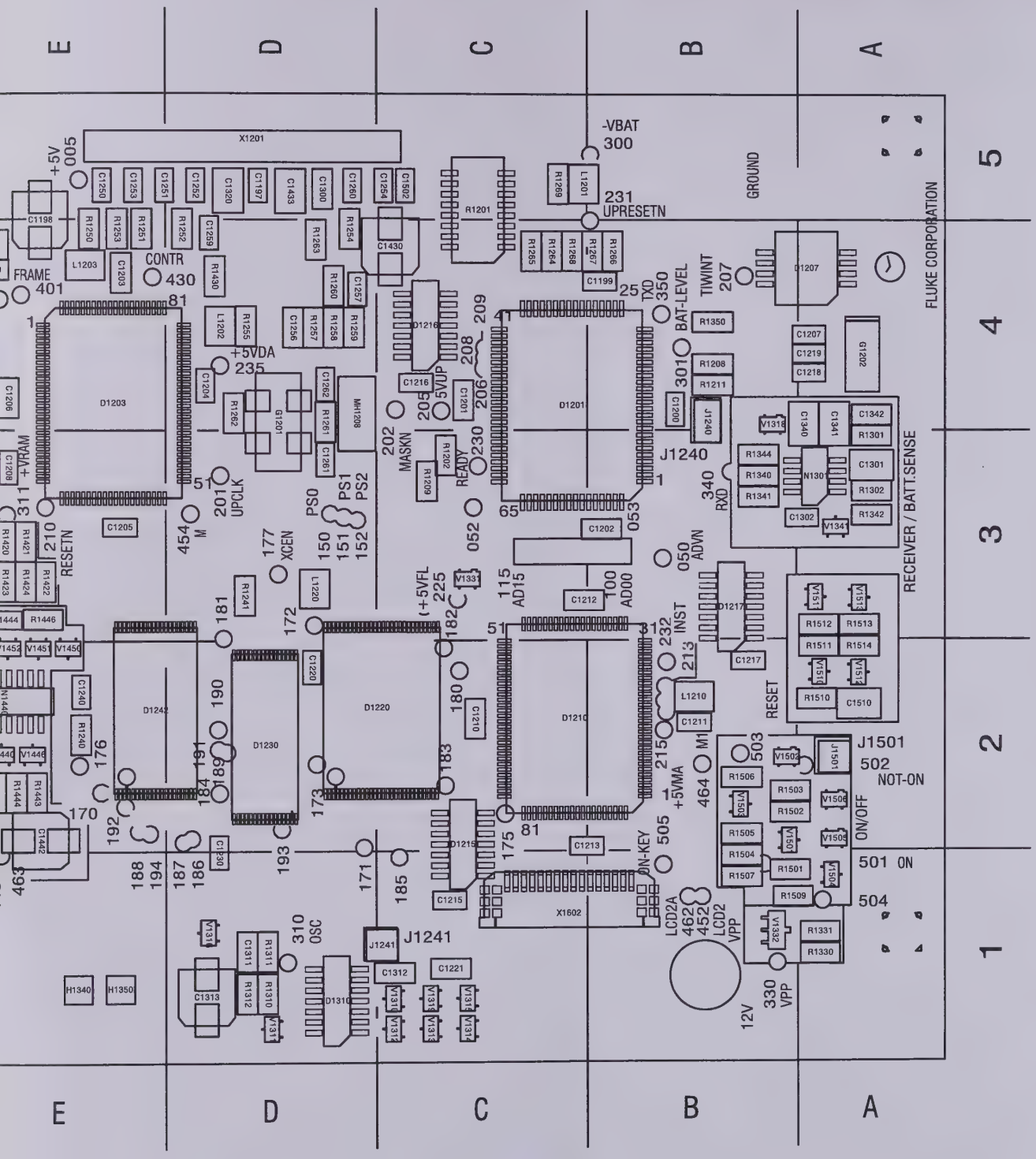


Figure 9.11 Digital A1 PCB


E
D
C
B
A
5
4
3
2
1
X1201
+5V
005
-VBAT
300
231
UPRESETN
GROUND
FLUKE CORPORATION
FRAME
401
CONTR
430
+5VDA
235
D1203
D1201
D1216
D1207
D1242
D1230
D1220
D1210
D1215
D1217
D1310
X1602
J1240
J1241
J1501
RECEIVER / BATT.SENSE
RESETN
XCEN
UPCLK
PS0
PS1
PS2
MASKN
READY
RXD
TXD
BAT-LEVEL
TIWINT
ADVN
INST
AD15
AD00
RESET
ON-KEY
ON/OFF
NOT-ON
ON
OSC
LCD2A
LCD2
VPP
12V
330
VPP
ST8008
960301

PARTS LOCATION A1 PCB

C1197	D5	C1404	G2	J1501	A2	R1350	B4	R1513	A3
C1198	E4	C1405	G4	L1201	C5	R1407	G3	R1514	A2
C1199	B4	C1406	G3	L1202	D4	R1411	H3	T1442	F2
C1200	B4	C1407	G3	L1203	E4	R1412	H3	V1310	C1
C1201	C4	C1418	G1	L1210	B2	R1413	G5	V1311	D1
C1202	B3	C1419	G1	L1220	D3	R1414	G1	V1312	C1
C1203	E4	C1420	H3	L1401	E4	R1415	G5	V1313	C1
C1204	D4	C1421	H3	L1442	F2	R1416	G1	V1314	C1
C1205	E3	C1422	G4	N1301	A3	R1417	H3	V1315	C1
C1206	E4	C1423	G4	N1420	F3	R1418	F3	V1316	D1
C1207	A4	C1424	H3	N1440	E2	R1419	H2	V1318	B4
C1208	E3	C1425	F3	NH1208	D4	R1420	E3	V1319	C1
C1210	C2	C1431	F5	R1201	C5	R1421	E3	V1331	C3
C1211	B2	C1432	F5	R1202	C3	R1422	E3	V1332	B1
C1212	C3	C1433	D5	R1208	B4	R1423	E3	V1339	F4
C1213	C2	C1434	H2	R1209	C3	R1424	E3	V1340	F4
C1215	C1	C1438	C4	R1211	B4	R1425	F2	V1341	A3
C1216	C4	C1440	F4	R1240	E2	R1426	F3	V1431	F4
C1217	B2	C1442	E2	R1241	D3	R1427	F3	V1432	F5
C1218	A4	C1443	F2	R1250	E4	R1428	F3	V1433	G4
C1219	A4	C1444	E3	R1251	E4	R1429	F3	V1434	G4
C1220	D2	C1445	F1	R1252	D4	R1430	D4	V1435	F4
C1221	C1	C1446	F1	R1253	E4	R1431	F4	V1440	E2
C1230	D2	C1502	C5	R1254	D4	R1432	F4	V1441	E2
C1240	E2	C1510	A2	R1255	D4	R1433	F4	V1445	F2
C1250	E5	D1201	C4	R1257	D4	R1434	F5	V1446	E2
C1251	E5	D1203	E4	R1258	D4	R1435	F5	V1447	F2
C1252	D5	D1207	A4	R1259	D4	R1436	F5	V1448	F2
C1253	E5	D1210	C2	R1260	D4	R1437	G5	V1449	E2
C1254	C5	D1215	C2	R1261	D4	R1438	F5	V1450	E2
C1256	D4	D1216	C4	R1262	D4	R1439	F5	V1451	E2
C1257	D4	D1217	B3	R1263	D4	R1440	E4	V1452	E2
C1259	D4	D1218	E4	R1264	C4	R1441	E2	V1501	B2
C1260	D5	D1230	D2	R1265	C4	R1442	E2	V1502	B2
C1261	D3	D1242	E2	R1266	B4	R1443	E2	V1503	B2
C1262	D4	D1310	D1	R1267	B4	R1444	E2	V1504	A1
C1300	D5	D1401	I4	R1268	C4	R1445	F2	V1505	A2
C1301	A3	D1402	I3	R1269	C5	R1446	E3	V1506	A2
C1302	A3	D1403	I2	R1301	A3	R1448	F2	V1506	B2
C1311	D1	D1404	H2	R1302	A3	R1501	B1	V1510	A2
C1312	C1	D1405	H4	R1310	D1	R1502	B2	V1511	A3
C1313	D1	D1406	H3	R1311	D1	R1503	B2	V1512	A2
C1320	D5	G1201	D4	R1312	D1	R1504	B1	V1513	A3
C1340	A4	G1202	A4	R1330	A1	R1505	B2	X1201	D5
C1341	A4	G1300	F4	R1331	A1	R1507	B1	X1602	C1
C1342	A4	H1340	E1	R1340	B3	R1509	B1		
C1401	H4	H1350	E1	R1341	B3	R1510	A2		
C1402	H2	J1240	B4	R1342	A3	R1511	A2		
C1403	H1	J1241	C1	R1344	B3	R1512	A3		

TESTPOINTS A1 PCB

005	+5V	E5
050	ADVN	B3
052		C3
053		B3
100	AD00	B3
101	AD01	B3
102	AD02	B3
103	AD03	B3
104	AD04	B3
105	AD05	B3
106	AD06	C3
107	AD07	C3
108	AD08	C3
109	AD09	C3
110	AD10	C3
111	AD11	C3
112	AD12	C3
113	AD13	C3
114	AD14	C3
115	AD15	C3
150	PS0	D3
151	PS1	D3
152	PS2	D3
170		E2
171		D2
172		D3
173		D2
174		F4
175		C2
176		E2
177	XCEN	D3
180		C2
181		D2/3
182		C2/3
183		C2
184		D2
185		C1
186		D2
187		D2
188		E2
190		D2
191		D2
192		E2
193		D2
194		E2
201	UPCLK	D3
202	MASKN	C4
203		F3
204		E4
205	5VUP	C4
206		C4
207	TIWINT	B4
208		C4
209		C4
210	RESETN	E3
213		B2
215		B2
225	+5VFL	C3
230	READY	C3
231	UPRESETN	B4/5
232	INST	B2
235	+5VDA	D4
300	-VBAT	B5
301	BAT-LEVEL	B4
310	OSC	D1
311		E3
330	VPP	B1
340	RXD	B3
350	TXD	B4
401	FRAME	E4
402	FR1	H3
403	FR2	H2
405		F3
406	CAR	G3
420	V1	F3
421	V6	F3
422	V3	F3
423	V4	F3
424	V5	F3
425	V2	F3
430	CONTR	E4
431	LCDPWR	F4/5
432	-30V	F5
440	TUBELOW	F4
442		E/F2
446		E1
450	LCD0	F3
451	LCD1	F4
452	LCD2	B1
453	LCD3	F3
454	M	D3
455	LINECL	F3
456	DATACL	F3
460	LCD0A	F4
461	LCD1A	E1/2
462	LCD2A	B1
463	LCD3A	E1
464	M1	B2

PARTS LOCATION A1 CIRCUIT DIAGRAM PART A

C1197	G2	C1301	C9	L1220	H4	R1505	B2	V1311	E4
C1198	G2	C1302	G3	L1401	I4	R1506	C2	V1312	E4
C1199	H4	C1311	F4	N1301	A10	R1507	C4	V1313	E4
C1200	H4	C1312	F6	R1202	D13	R1510	A5	V1314	E5
C1201	H5	C1313	E6	R1203	D12	R1511	A5	V1315	E5
C1202	H5	C1340	A11	R1264	E3	R1512	B5	V1316	E6
C1203	H4	C1341	B11	R1265	E3	R1513	B6	V1318B	E7
C1204	H4	C1342	B10	R1266	D3	R1514	B6	V1319	D5
C1205	H5	C1401	I4	R1267	D3	TP005	G6	V1331A	H9
C1206	H5	C1402	I4	R1268	D3	TP207	B8	V1331B	H9
C1207	E8	C1403	I5	R1269	E3	TP208	H6	V1332	H8
C1208	E7	C1404	I5	R1301	D8	TP210	B8	V1340A	B9
C1210	I4	C1405	I5	R1302	C9	TP215	I6	V1430A	E7
C1211	I4	C1406	I6	R1310	F4	TP225	H6	V1341	B11
C1212	I5	C1502	B2	R1311	E5	TP235	H6	V1501	A2
C1213	I5	C1510	B6	R1312	E5	TP300	C2	V1502A	B3
C1215	E7	D1207	B9	R1330	H8	TP301	D9	V1502B	B2
C1216	H5	D1215	B7	R1331	H8	TP310	F3	V1503	B3
C1217	I5	D1232	G2	R1340	A9	TP311	E7	V1504	B4
C1218	A8	D1310	E5	R1341	A11	TP330	H9	V1505	B4
C1219	A8	G1202	B8	R1342	C11	TP340	B12	V1506	B4
C1220	H4	G1300	F7	R1343	B10	TP350	A13	V1510	A6
C1221	H9	H1340	B11	R1344	B10	TP405	I6	V1511	B5
C1230	E8	H1350	A12	R1350	B12	TP501	B2	V1512	B6
C1240	H4	J1501	C3	R1501	A3	TP502	B4	V1513	B7
C1259	E2	L1201	H4	R1502	A3	TP503	C4	X1201	B1
C1260	E2	L1203	H4	R1503	B3	TP504	B4	X1204	H8
C1300	D2	L1210	I4	R1504	B2	V1310	F6	X1205	H8

PARTS LOCATION A1 CIRCUIT DIAGRAM PART B

D1201	A17	R1210	D21	TP109	C23	TP181	A24	TP205	D17
D1210	A20	R1211	A15	TP110	C23	TP182	A24	TP206	D16
D1215	H23	R1240	E23	TP111	D23	TP183	B24	TP207	B15
D1215	J23	R1241	F23	TP112	D23	TP184	B24	TP209	D18
D1221	B28	TP050	A21	TP113	D23	TP185	B24	TP211	D21
D1222	B26	TP052	A21	TP114	D23	TP186	B24	TP212	D22
D1230	G26	TP053	A21	TP115	E23	TP187	C24	TP213	D21
D1242	D26	TP100	A23	TP151	B21	TP188	C24	TP230	D22
J1240	G21	TP101	A23	TP152	B21	TP189	C24	TP231	G20
J1241	B27	TP102	A23	TP170	E24	TP190	C24	TP232	D20
R1201	B14	TP103	B23	TP171	E24	TP191	D24	TP233	B15
R1202	D15	TP104	B23	TP172	E24	TP192	D24	V1430B	E18
R1203	D15	TP105	B23	TP173	E24	TP193	D24	X1602	H19
R1207	A15	TP106	B23	TP174	I24	TP194	D24		
R1208	B15	TP107	C23	TP177	H24	TP201	A17		
R1209	E21	TP108	C23	TP180	A24	TP202	A16		

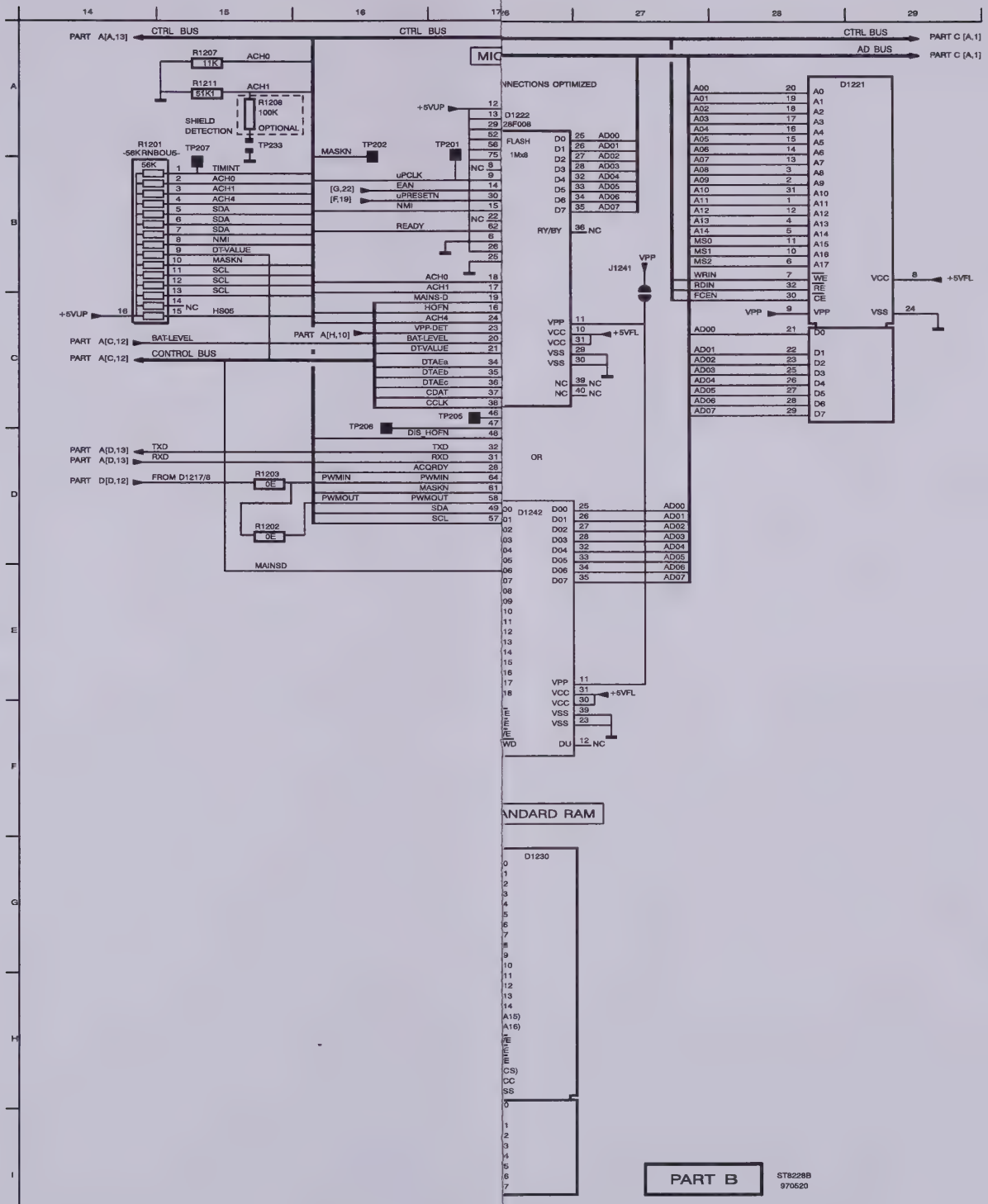
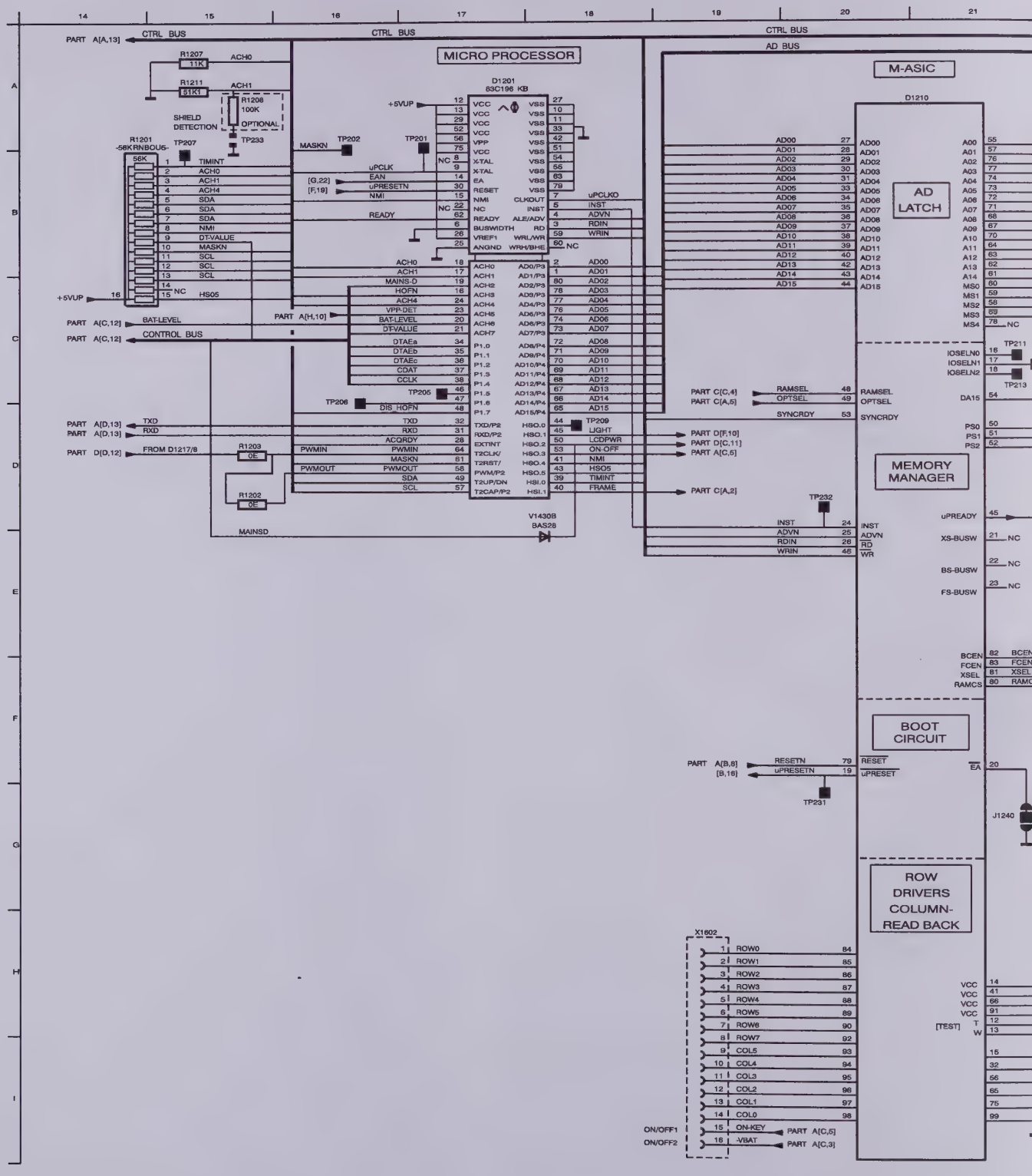


Figure 9.3 Digital A1 circuit diagram (part B)

PARTS LOCATION A1 CIRCUIT DIAGRAM PART B

D1201	A17	R1210	D21	TP109	C23	TP181	A24	TP205	D17
D1210	A20	R1211	A15	TP110	C23	TP182	A24	TP206	D16
D1215	H23	R1240	E23	TP111	D23	TP183	B24	TP207	B15
D1215	J23	R1241	F23	TP112	D23	TP184	B24	TP209	D18
D1221	B28	TP050	A21	TP113	D23	TP185	B24	TP211	D21
D1222	B26	TP052	A21	TP114	D23	TP186	B24	TP212	D22
D1230	G26	TP053	A21	TP115	E23	TP187	C24	TP213	D21
D1242	D26	TP100	A23	TP151	B21	TP188	C24	TP230	D22
J1240	G21	TP101	A23	TP152	B21	TP189	C24	TP231	G20
J1241	B27	TP102	A23	TP170	E24	TP190	C24	TP232	D20
R1201	B14	TP103	B23	TP171	E24	TP191	D24	TP233	B15
R1202	D15	TP104	B23	TP172	E24	TP192	D24	V1430B	E18
R1203	D15	TP105	B23	TP173	E24	TP193	D24	X1602	H19
R1207	A15	TP106	B23	TP174	I24	TP194	D24		
R1208	B15	TP107	C23	TP177	H24	TP201	A17		
R1209	E21	TP108	C23	TP180	A24	TP202	A16		


MICRO PROCESSOR
M-ASIC
AD BUS
CTRL BUS
AD LATCH
MEMORY MANAGER
BOOT CIRCUIT
ROW DRIVERS COLUMN-READ BACK
D1201 83C196 KB
D1210
R1207 11K
R1211 51K1
R1208 100K OPTIONAL
SHIELD DETECTION
R1201 -56KRNBOU5-
TP207
TP233
TP202
TP201
MASKN
uPCLK
READY
BAT-LEVEL
CONTROL BUS
TXD
RXD
FROM D1217/8
R1203 0E
R1202 0E
MAINSD
V1430B BAS28
TP205
TP206
DIS_HOFN
TP209
LIGHT
LCDPWR
ON-OFF
TP232
TP231
RESETN
uPRESETN
RESET
uPRESET
J1240
X1602
ON-KEY
VBAT
ON/OFF1
ON/OFF2
TP211
TP213
IOSELN0
IOSELN1
IOSELN2
RAMSEL
OPTSEL
SYNCRDY
DA15
PS0
PS1
PS2
uPREADY
XS-BUSW
BS-BUSW
FS-BUSW
BCEN
FCEN
XSEL
RAMCS
TEST
VCC

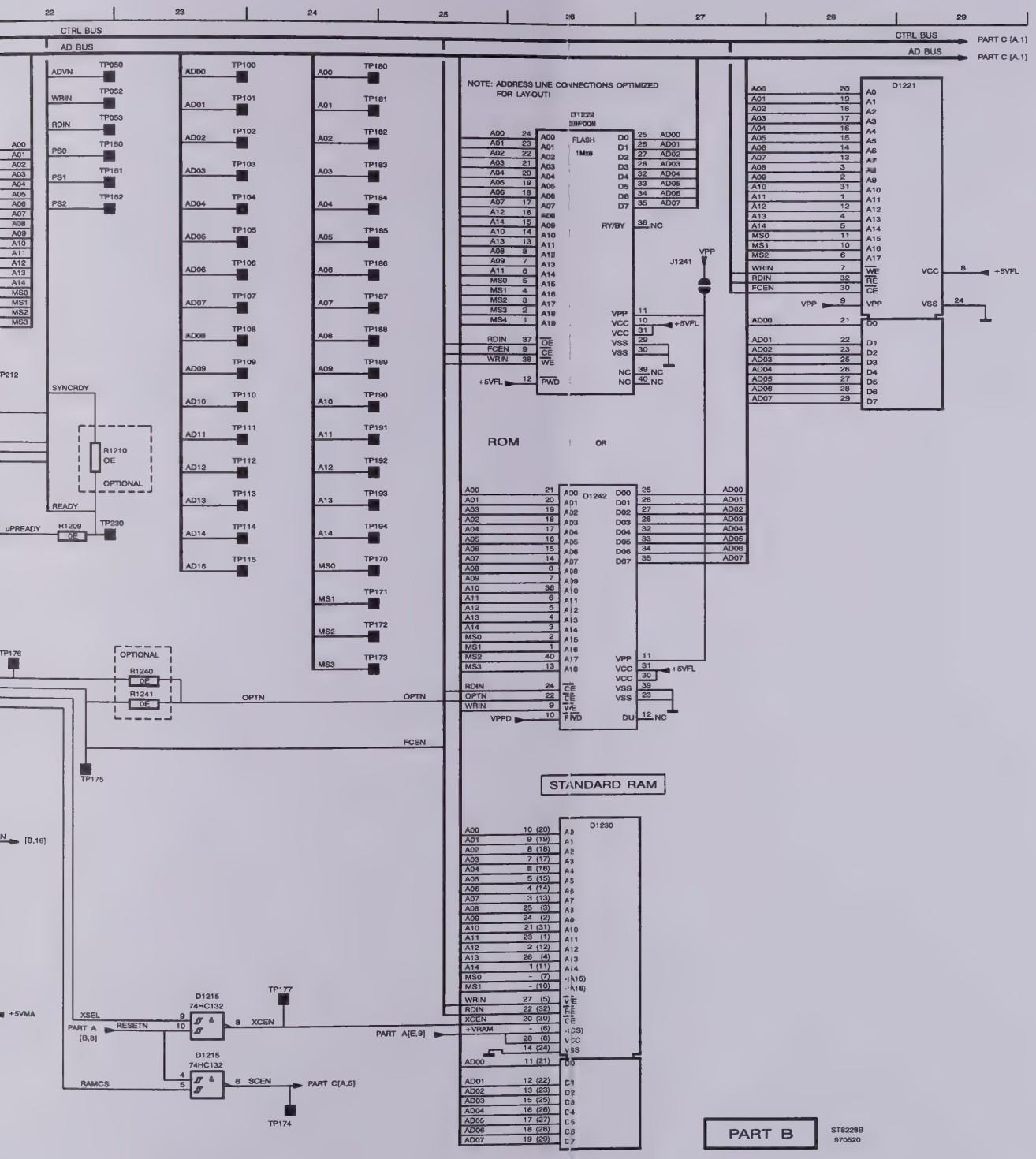


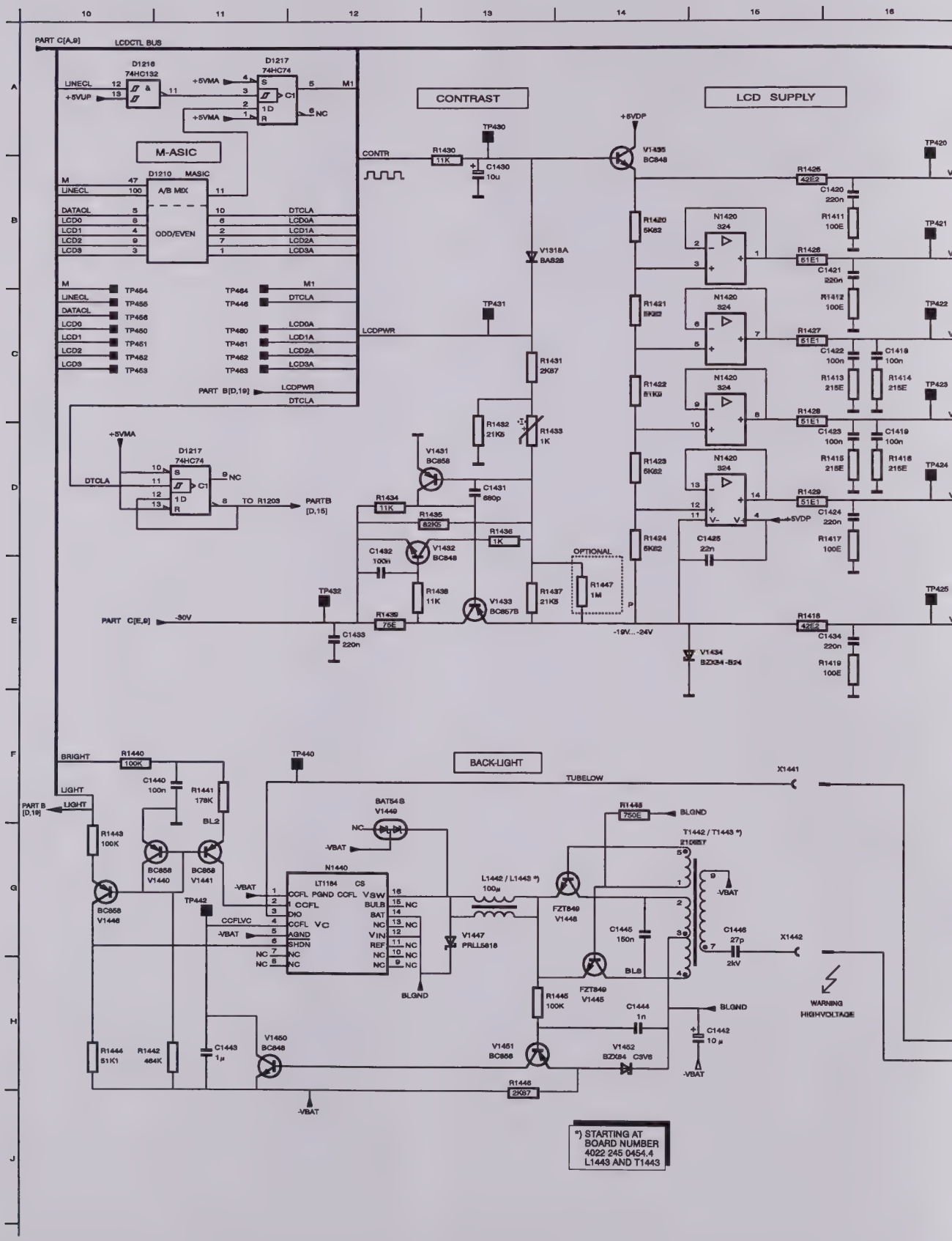
Figure 9.3 Digital A1 circuit diagram (part B)

PARTS LOCATION AI PCB CIRCUITDIAGRAM PART C

C1250	E7	C1257	F5	D1218	A7	R1254	F7	R1261	H3
C1251	E7	C1258	F7	G1201	G3	R1255	F7	R1262	H4
C1252	E7	C1261	H3	L1202	F6	R1256	F7	R1263	H7
C1253	F7	C1262	H3	R1250	E7	R1257	F5	TP203	A5
C1254	F7	D1203	D3	R1251	E7	R1258	F5	TP204	A5
C1255	F7	D1208	A6	R1252	E7	R1259	F6		
C1256	F5	D1209	A6	R1253	F7	R1260	G7		

PARTS LOCATION AI PCB CIRCUITDIAGRAM PART D

C1320	G14	D1217	A11	R1420	B14	TP401	B17	TP456	C10
C1407	F17	D1401	A19	R1421	C14	TP402	B20	TP460	C11
C1418	C16	D1402	A21	R1422	C14	TP403	B22	TP461	C11
C1419	D16	D1403	A23	R1423	D14	TP406	D17	TP462	C11
C1420	B16	D1404	C19	R1424	D14	TP420	B16	TP463	C11
C1421	B16	D1405	E19	R1425	B15	TP421	B16	TP464	C11
C1422	C16	D1406	G19	R1426	B15	TP422	C16	V1318A	B13
C1423	D16	L1442	F13	R1427	C15	TP423	C16	V1340B	H14
C1424	D16	N1420	B15	R1428	C15	TP424	D16	V1431	D13
C1425	D15	N1440	G12	R1429	D15	TP425	E16	V1432	D12
C1430	B13	R1439	E12	R1430	B13	TP430	A13	V1433	E13
C1431	D13	R1440	F10	R1431	C13	TP431	C13	V1434	E15
C1432	D12	R1441	F11	R1432	D13	TP432	E12	V1435	B14
C1433	E12	R1442	H11	R1433	D13	T1442	G14	V1440	F10
C1434	E13	R1443	F10	R1434	D12	TP440	F12	V1441	F11
C1440	F11	R1407	G17	R1435	D13	TP442	F11	V1445	G13
C1442	H14	R1411	B16	R1436	D13	TP446	C11	V1446	F10
C1443	H11	R1412	B16	R1437	E13	TP450	C10	V1447	G13
C1444	H14	R1413	C16	R1438	E12	TP451	C10	V1448	F13
C1445	G14	R1414	C16	R1444	H10	TP452	C10	V1449	F12
C1446	G15	R1415	D16	R1445	G13	TP453	C10	V1450	H11
D1210	B11	R1419	D16	R1446	H13	TP454	C10	V1451	H13
D1216	A10	R1417	D16	R1448	F14	TP455	C10	V1452	H14


CONTRAST
LCD SUPPLY
M-ASIC
BACK-LIGHT
LCDCTL BUS
D1216 74HC132
D1217 74HC74
D1210 MASIC
A/B MIX
ODD/EVEN
LINECL
DATACL
LCD0
LCD1
LCD2
LCD3
DTCLA
M1
CONTR
LCDPWR
BRIGHT
LIGHT
TUBELOW
+5VMA
+5VUP
+5VDP
-30V
-VBAT
BLGND
PART B [D,19]
PART C[A,9]
PART C[E,9]
TO R1203
PARTB [D,15]
OPTIONAL
-19V...-24V
N1420 324
N1440
LT1184 CS
V1435 BC848
V1431 BC858
V1432 BC848
V1433 BC857B
V1434 BZX84-S24
V1440 BC858
V1441 BC858
V1446 BC858
V1450 BC848
V1451 BC858
V1452 BZX84 C5V6
V1447 PRLL5818
V1448 BAT54S
FZT849 V1448
FZT849 V1445
V1318A BAS28
R1420 5K62
R1421 5K62
R1422 5K62
R1423 5K62
R1424 5K62
R1425 42E2
R1426 51E1
R1427 51E1
R1428 51E1
R1429 51E1
R1430 11K
R1431 2K87
R1432 21K5
R1433 1K
R1434 11K
R1435 82K5
R1436 1K
R1437 21K5
R1438 11K
R1439 75E
R1440 100K
R1441 178K
R1443 100K
R1444 51K1
R1442 464K
R1445 100K
R1446 750E
R1447 1M
R1448 2K87
C1420 220n
C1421 220n
C1422 100n
C1423 100n
C1424 220n
C1425 22n
C1426 100n
C1427 100n
C1428 100n
C1429 100n
C1430 10u
C1431 680p
C1432 100n
C1433 220n
C1434 220n
C1440 100n
C1441 178K
C1442 10µ
C1443 1µ
C1444 1n
C1445 150n
C1446 27p 2kV
R1411 100E
R1412 100E
R1413 215E
R1414 215E
R1415 215E
R1416 215E
R1417 100E
R1418 42E2
R1419 100E
T1442 / T1443 *)
L1442 / L1443 *)
100µ
X1441
X1442
WARNING HIGHVOLTAGE
TP420
TP421
TP422
TP423
TP424
TP425
TP430
TP431
TP432
TP440
TP442
*) STARTING AT BOARD NUMBER 4022 245 0454.4 L1443 AND T1443

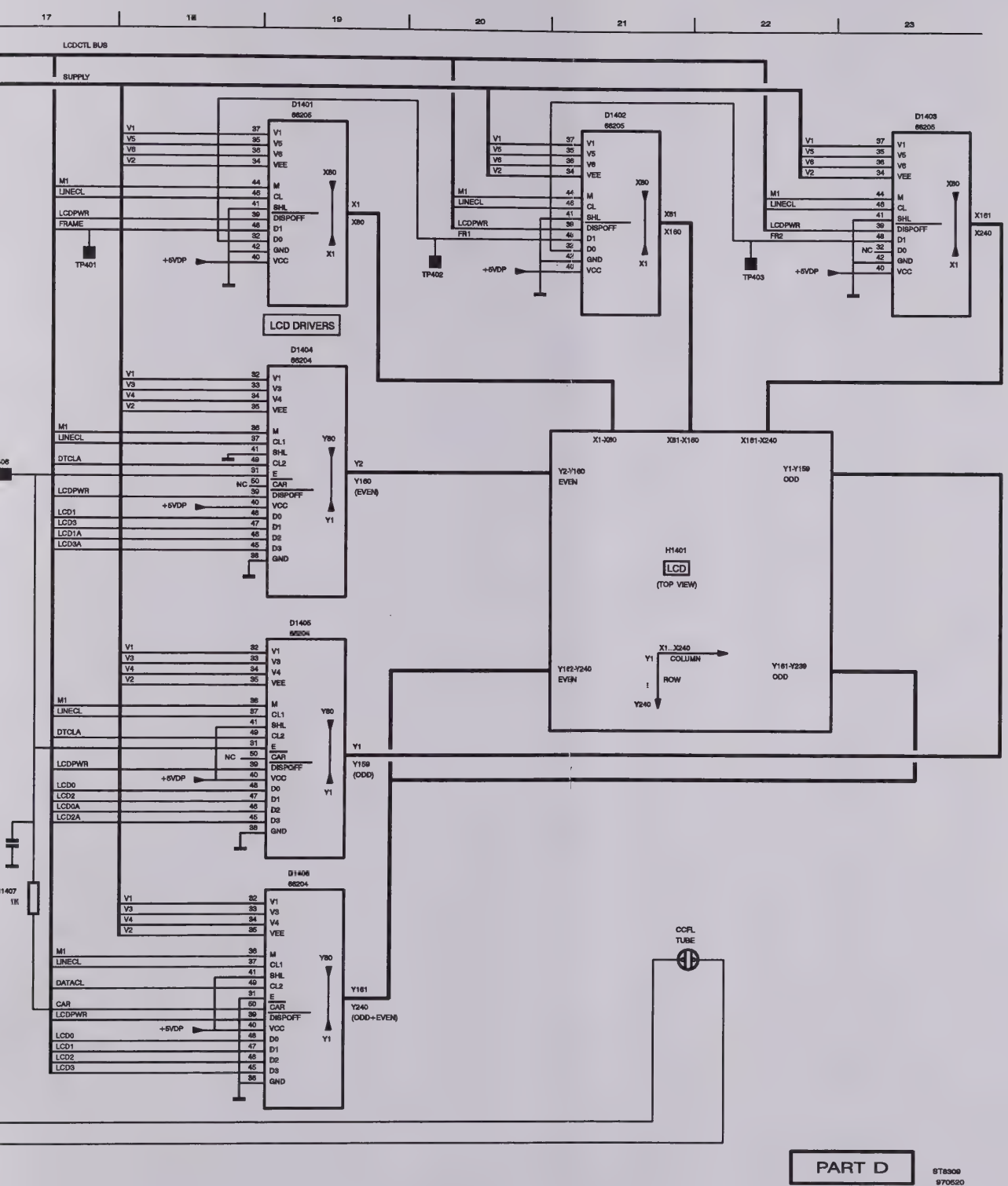


Figure 9.5 Digital A1 circuit diagram (part D)

G
F
E
D
1
2
3
4
5
SMD-SIDE

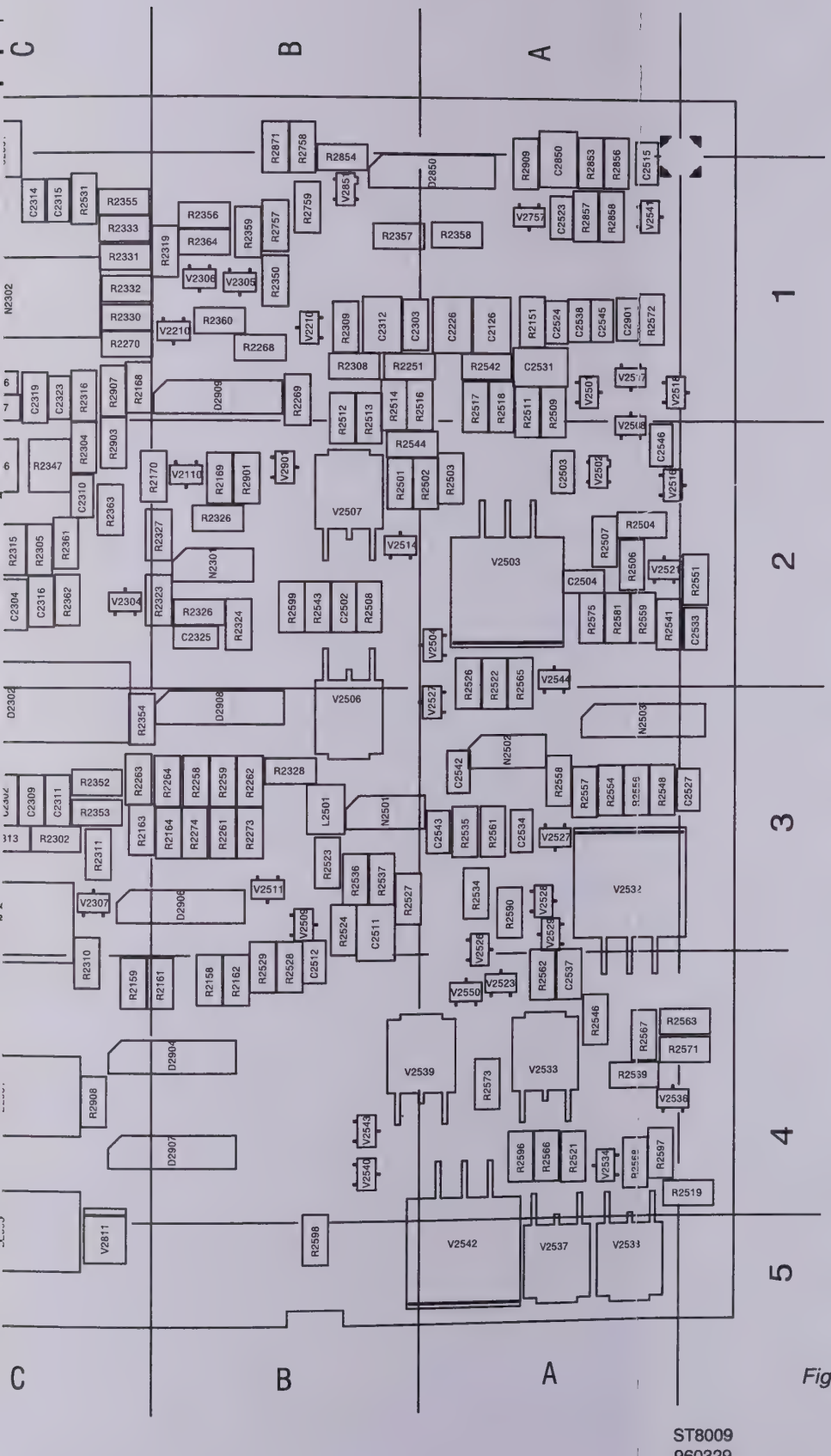


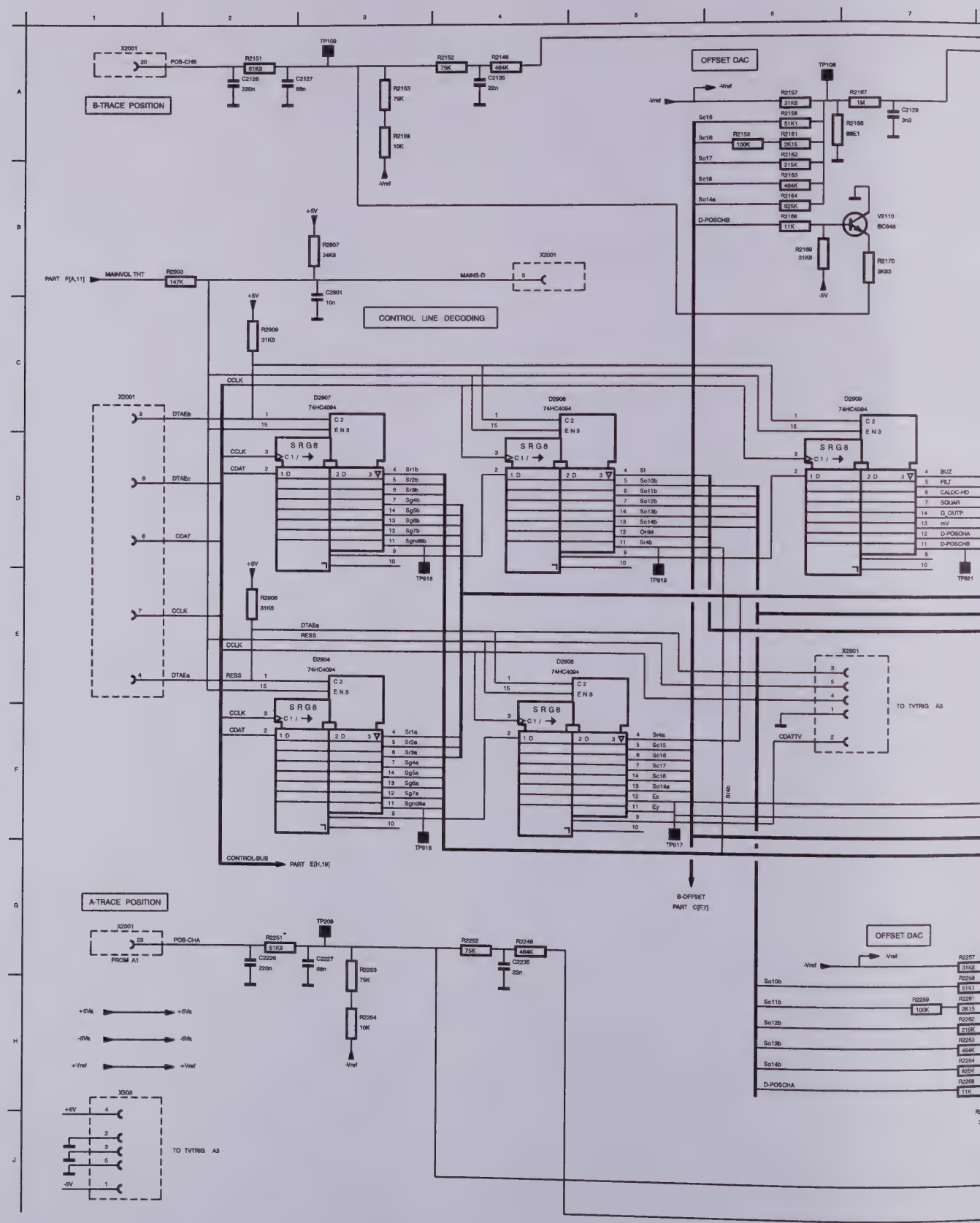
Figure 9.6 *ANALOG BOARD A2 assembly (SMD components side)*

PARTS LOCATION A2 (PCB WIRED COMPONENTS SIDE)

C2102	F4	C2506	B3	L2504	A4	TP203	D2	TP701	E2
C2103	F4	C2507	A2	L2506	A4	TP204	D1	TP702	C3
C2104	E4	C2508	B3	R2119	F4	TP206	D1	TP704	F3
C2106	E4	C2509	A2	R2156	F4	TP207	D1	TP706	F2
C2108	E4	C2514	A2	R2176	F4	TP208	D3	TP801	C1
C2111	E4	C2516	A1	R2219	F1	TP209	C1	TP802	E2
C2112	E4	C2517	A1	R2256	F1	TP331	C1	TP803	F2
C2113	E4	C2518	C1	R2276	F1	TP332	C1	TP804	F2
C2116	E4	C2521	D1	R2582	A5	TP501	C2	TP805	E2
C2141	F5	C2530	A2	R2750	F3	TP502	C2	TP806	E2
C2150	F4	C2532	A1	R2753	F2	TP503	C2	TP901	C4
C2202	F1	C2547	D5	R2778	F3	TP504	C2	TP902	C4
C2203	F1	C2549	C5	T2501	A2	TP506	B2	TP903	C3
C2204	E1	C2552	A2	X503	C2	TP508	D2	TP904	C3
C2206	E1	C2750	F3	X2001	A1	TP509	B3	TP906	C3
C2208	E1	H2901	B1	X2501	B4	TP511	C1	TP907	D3
C2211	E1	K2101	F5	X2502	A4	TP520	B4	TP908	C3
C2212	E1	K2102	E4	X2701	D3	TP521	C5	TP909	C3
C2213	E1	K2103	E4	X2901	C4	TP522	B3	TP911	D4
C2216	E1	K2201	F1	Z2501	B4	TP523	C2	TP912	C4
C2241	F1	K2202	E1	TP102	D3	TP524	B3	TP914	C4
C2250	F1	K2203	E1	TP103	D3	TP526	C4	TP916	B4
C2317	C1	K2750	F3	TP106	D5	TP527	B4	TP917	C4
C2322	C1	K2751	F2	TP107	D4	TP528	C4	TP918	B4
C2324	C1	L2502	A1	TP201	E2	TP529	C5	TP919	B2
C2501	B2	L2503	B1	TP202	D2	TP700	E2	TP921	B1

PARTS LOCATION A2 PCB CIRCUITDIAGRAM PART A

C2126	A2	D2906	E5	R2252	G4	R2773	G4	TP921	D7
C2127	A2	D2907	C2	R2252	H7	R2774	G4	V2110	B7
C2129	A7	D2908	C3	R2253	H3	R2775	E5	V2736	D8
C2131	A11	D2909	C7	R2253	H3	R2776	E9	V2751	C4
C2132	B11	H2901	C8	R2254	H3	R2777	C4	V2752	D4
C2133	B11	K2101	A11	R2257	G7	R2778	cl	V2753	D4
C2134	C11	K2201	C11	R2258	G7	R2901	C8	V2754	C6
C2135	A4	K2202	C11	R2259	G7	R2903	B2	V2755	H5
C2226	G2	K2203	D11	R2261	H7	R2904	A9	V2756	C6
C2227	G3	K2750	C3	R2262	H7	R2906	cio	V2757	A4
C2229	G8	K2750	D2	R2263	H7	R2907	B3	V2758	B3
C2232	D11	K2750	F11	R2264	H7	R2908	E2	V2759	F5
C2233	D11	K2751	D4	R2266	G8	R2909	C2	V2760	F4
C2234	D11	K2751	E11	R2267	G8	TP108	A6	V2761	G4
C2235	G4	K2751	F2	R2268	H7	TP109	A3	V2762	F5
C2705	H3	N2751	G3	R2269	H7	TP208	G8	V2763	F6
C2707	E4	N2751	G4	R2270	H8	TP209	G3	V2764	H5
C2757	D6	R2148	A4	R2729	G3	TP700	D4	V2765	D2
C2758	B3	R2151	A2	R2750	C3	TP701	D4	V2766	D2
C2758	D6	R2152	A4	R2753	C4	TP702	B3	V2767	D8
C2759	E6	R2153	A3	R2754	C5	TP704	G3	V2768	E10
C2760	B3	R2154	A3	R2755	D3	TP706	G4	V2769	C4
C2761	C6	R2157	A6	R2757	A4	TP717	F5	V2811	F11
C2762	D9	R2158	A6	R2759	B3	TP901	A11	V2812	F11
C2763	D8	R2159	A6	R2760	D5	TP902	B11	X503	J1
C2801	C1	R2161	A6	R2761	D7	TP903	B11	X503	J1
C2804	F11	R2162	B6	R2762	D10	TP904	B11	X2001	A1
C2806	F11	R2163	B6	R2763	D5	TP906	C11	X2001	B4
C2901	B3	R2164	B6	R2764	D5	TP907	C11	X2001	C1
D2750	D7	R2166	A6	R2765	D10	TP908	D11	X2001	F1
D2751	D9	R2167	A7	R2766	E5	TP909	D11	X2001	G1
D2850	A2	R2168	B6	R2767	D6	TP911	E11	X2201	F1
D2850	D12	R2169	B6	R2768	D6	TP912	E11	X2901	F6
D2901	A10	R2170	B7	R2769	D7	TP914	F11	X2901	F6
D2902	C10	R2248	G4	R2770	E5	TP916	F3		
D2903	E10	R2251	G2	R2771	H3	TP918	D3		
D2904	E3	R2251	H7	R2772	H4	TP919	D5		


B-TRACE POSITION
A-TRACE POSITION
CONTROL LINE DECODING
OFFSET DAC
OFFSET DAC
X2001
POS-CHB
POS-CHA
FROM A1
MAINVOL THT
PART F[A,11]
MAINS-D
CCLK
CDAT
RESS
DTAEa
DTAEb
DTAEc
CONTROL-BUS
PART E[H,19]
B-OFFSET
PART C[F,7]
TO TVTRIG A3
CDATTV
D-POSCHA
D-POSCHB
D2907
D2908
D2909
74HC4094
SRG8
X2901
X508
+5V
-5V
-Vref
+Vref

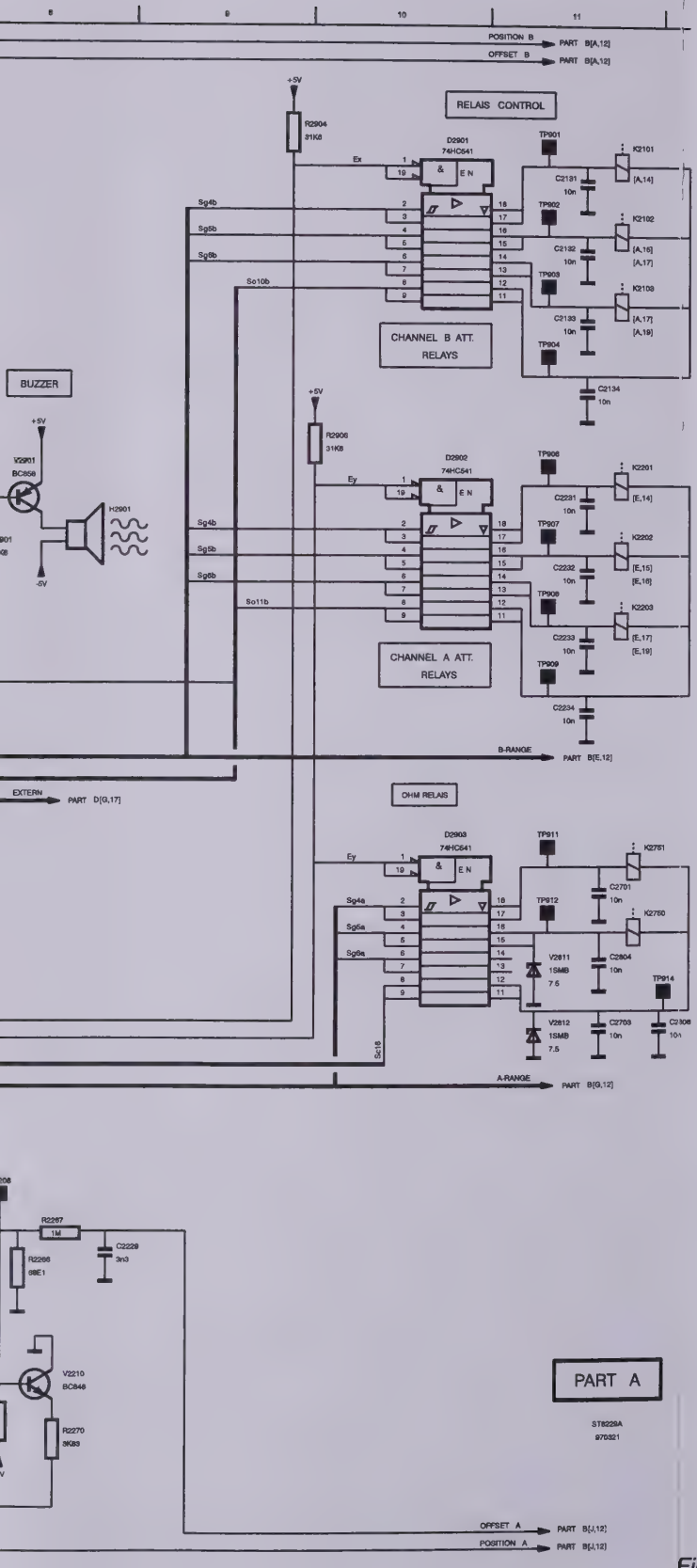


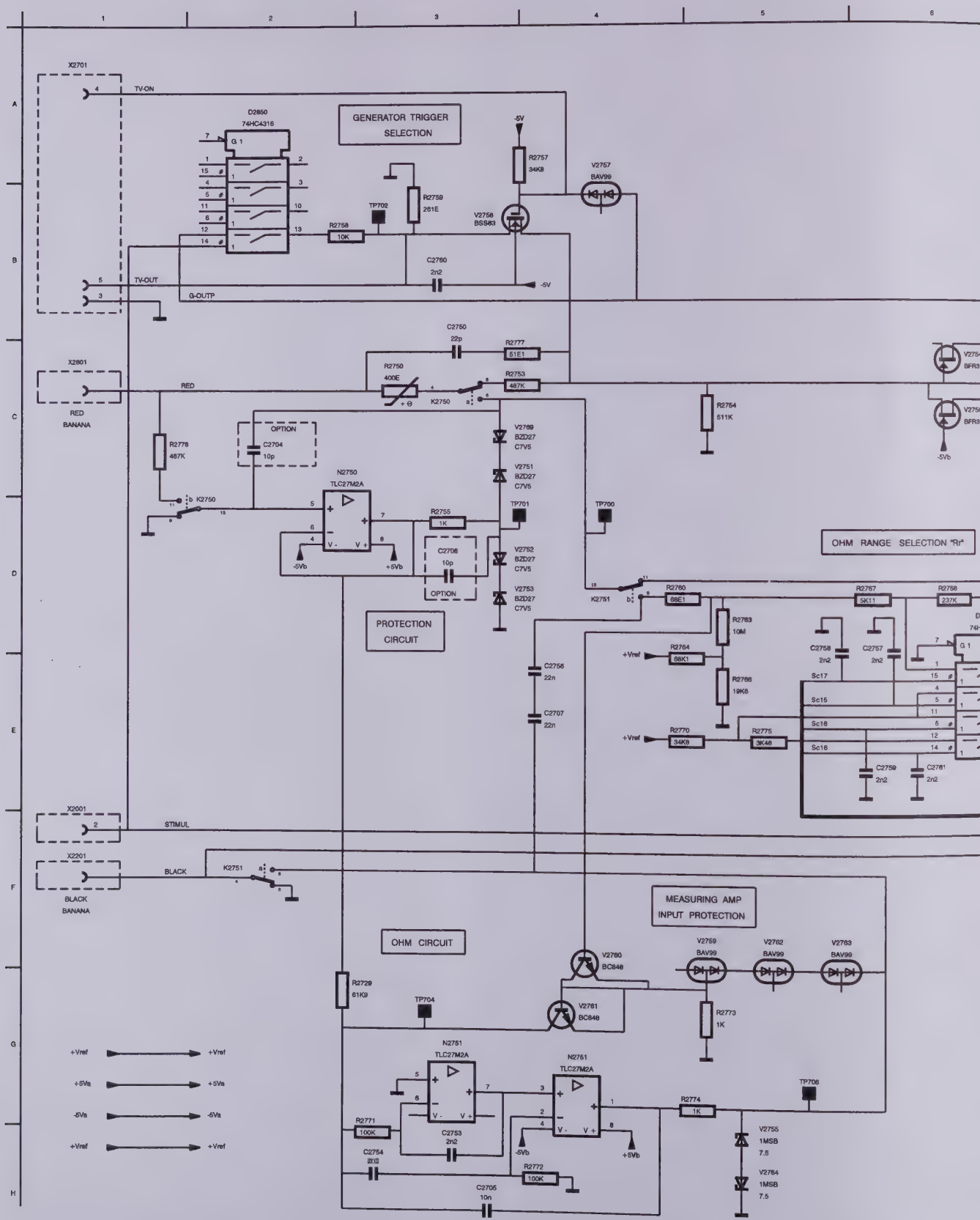
Figure 9.8 Analog A2 PCB circuit diagram (part A)

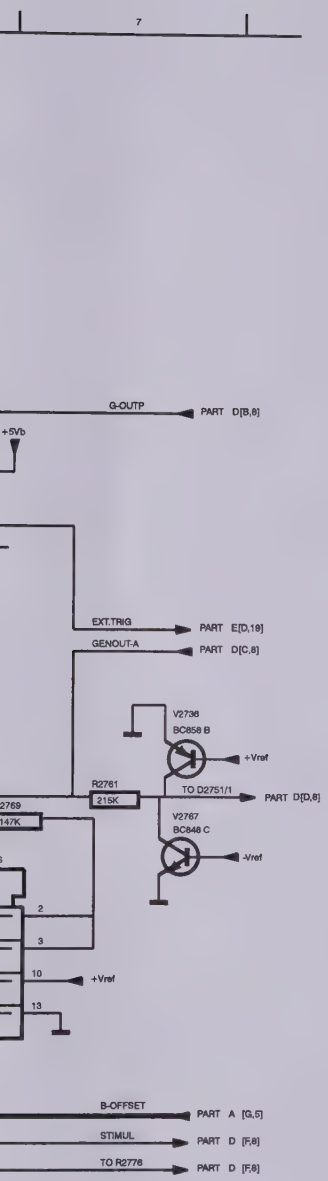
PARTS LOCATION A2 PCB CIRCUITDIAGRAM PART B

C2102	A14	C2212	E18	R2106	A16	R2175	D23	R2249	G22
C2103	H15	C2213	F18	R2107	B16	R2176	B14	R2250	H20
C2104	A16	C2214	F18	R2108	A18	R2177	B23	R2255	F21
C2105	B19	C2215	G15	R2109	A19	R2196	B17	R2256	F13
C2106	A16	C2216	E19	R2110	A19	R2201	E13	R2260	E23
C2107	A16	C2217	F19	R2111	B20	R2203	E14	R2265	H22
C2108	A17	C2218	J22	R2112	A20	R2204	E15	R2271	H14
C2109	B17	C2219	F21	R2113	B21	R2205	E16	R2272	G21
C2111	A18	C2220	H15	R2114	B21	R2206	E15	R2275	J23
C2112	A18	C2221	F19	R2115	B19	R2207	F16	R2276	F14
C2113	A18	C2222	G19	R2116	B21	R2208	E17	R2277	F23
C2114	A19	C2223	E21	R2117	A22	R2209	F19	R2298	F17
C2115	C15	C2223	H20	R2118	C13	R2210	E19	R2299	G24
C2116	A19	C2224	H22	R2119	B13	R2211	F20	TP101	D12
C2117	B19	C2225	E20	R2120	C15	R2212	F20	TP102	C14
C2118	D22	C2228	F17	R2121	C13	R2213	F21	TP103	C16
C2119	B21	C2230	H20	R2123	A21	R2214	F21	TP104	C16
C2120	D15	C2236	J23	R2124	D15	R2215	F19	TP106	B20
C2121	B20	C2237	E23	R2125	B16	R2216	F21	TP107	B24
C2122	C19	C2238	E21	R2126	D15	R2217	F22	TP201	H12
C2123	D20	C2239	H14	R2127	D16	R2218	G13	TP202	G13
C2123	A21	C2240	F22	R2128	C15	R2219	F13	TP203	G16
C2124	C23	C2241	H19	R2129	C16	R2220	G15	TP204	G16
C2125	A20	C2241	F16	R2130	D15	R2221	G13	TP206	F20
C2125	A20	C2242	J17	R2131	D16	R2222	H13	TP207	F24
C2128	A17	C2243	J17	R2132	D16	R2223	E21	V2104	B20
C2130	D20	C2245	H14	R2133	C16	R2224	H14	V2105	C16
C2136	E23	C2246	H19	R2134	C17	R2225	F15	V2106	A20
C2137	A23	C2247	E22	R2135	A22	R2226	H15	V2107	A21
C2138	A21	C2248	G21	R2136	C17	R2227	H15	V2108	C21
C2139	D14	C2248	G22	R2137	C18	R2228	H15	V2109	A23
C2140	B22	C2249	F13	R2138	C19	R2229	G16	V2111	C23
C2141	B16	C2250	F13	R2139	C20	R2230	H15	V2112	D13
C2144	C19	D2101	C14	R2140	C20	R2231	H16	V2113	D13
C2145	D14	D2102	C17	R2141	D20	R2232	H16	V2114	B22
C2146	C19	D2201	G14	R2142	D21	R2233	G16	V2204	F20
C2147	A21	D2202	H17	R2143	C23	R2234	G17	V2205	G15
C2148	B22	K2103	A19	R2144	D23	R2235	F22	V2206	E20
C2149	B13	K2201	E14	R2145	C22	R2236	G17	V2207	E21
C2150	B13	K2203	E19	R2146	C23	R2237	G18	V2208	G21
C2202	E14	K2203	E17	R2147	D22	R2238	G19	V2209	F23
C2203	E15	N2101	C15	R2149	C22	R2239	G20	V2211	G22
C2204	E16	N2101	C15	R2150	D20	R2240	G20	V2212	H12
C2205	F19	N2101	C19	R2155	B22	R2241	H20	V2213	H13
c2206	F16	N2201	G19	R2156	B13	R2242	H21	V2214	G22
C2207	F16	N2201	G15	R2160	A23	R2243	G22	X2108	A13
C2208	f16	R2101	A14	R2165	D22	R2245	G22	X2109	A13
C2209	F17	R2103	A14	R2171	D14	R2246	G23	X2208	E13
C2211	F18	R2104	A16	R2172	B22	R2247	H22		

PARTS LOCATION A2 PCB CIRCUITDIAGRAM PART C

C2704	C2	K2750	D1	R2760	D5	R2778	C1	V2759	F5
C2705	H3	K2751	D4	R2761	D7	TP700	D4	V2760	F4
C2706	D3	K2751	F2	R2763	D5	TP701	D4	V2761	G4
C2707	E4	N2750	D2	R2764	D5	TP702	B3	V2762	F5
C2750	C3	N2751	G3	R2766	E5	TP704	G3	V2763	F5
C2753	H3	N2751	G4	R2767	D6	TP706	G5	V2764	H5
C2754	H3	R2729	G2	R2768	D6	V2736	D7	V2767	D7
C2756	E4	R2750	C3	R2769	D6	V2751	C3	V2769	C3
C2758	D5	R2753	C4	R2770	E5	V2752	D3	X2001	F1
C2759	E6	R2754	C5	R2771	H3	V2753	D3	X2201	F1
C2760	B3	R2755	D3	R2772	H4	V2754	C6	X2701	A1
C2761	E6	R2757	A4	R2773	G5	V2755	H5	X2801	C1
D2750	D6	R2758	B2	R2774	G5	V2756	C6		
D2850	A2	R2759	B3	R2775	E5	V2757	B4		
K2750	C3	R2760	D4	R2777	C4	V2758	B3		


GENERATOR TRIGGER SELECTION
PROTECTION CIRCUIT
OHM RANGE SELECTION "Ri"
OHM CIRCUIT
MEASURING AMP INPUT PROTECTION
X2701
TV-ON
TV-OUT
G-OUTP
X2801
RED
RED BANANA
X2001
STIMUL
X2201
BLACK
BLACK BANANA
D2850 74HC4316
TP700
TP701
TP702
TP704
TP706
N2750 TLC27M2A
N2751 TLC27M2A
K2750
K2751
OPTION
+Vref
+5Va
-5Va
+Vref
+5Vb
-5Vb



PART C

ST8229C
970921

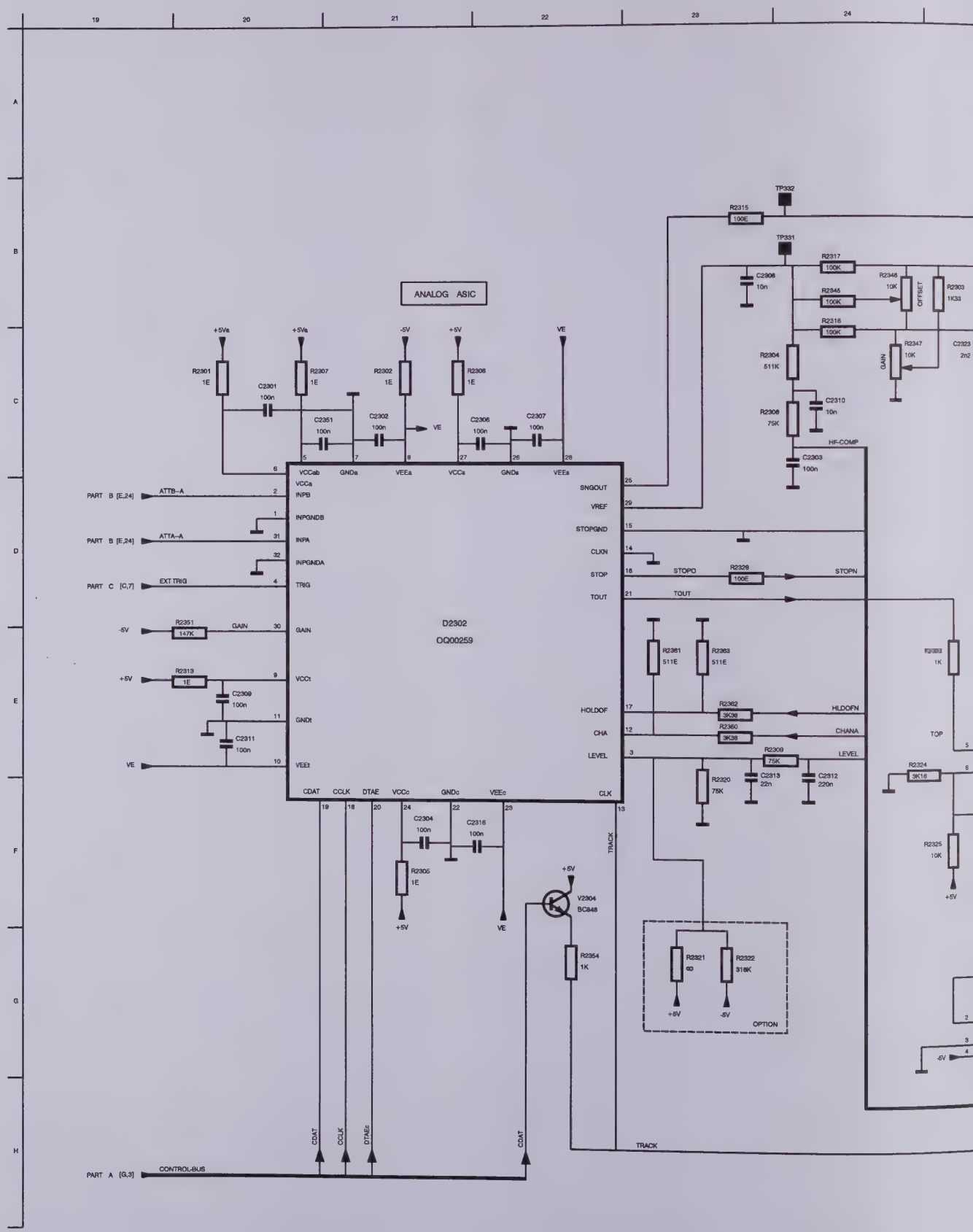
Figure 9.10 Analog A2 PCB circuit diagram (part C)

PARTS LOCATION A2 PCB CIRCUITDIAGRAM PART D

C2752	D10	C2863	E16	R2853	E13	R2865	B14	R2879	B16
C2762	D9	C2864	A16	R2854	E13	R2867	F14	TP801	D13
C2763	D8	C2866	F14	R2856	D13	R2868	F14	TP802	F14
C2850	E13	C2867	E17	R2857	E13	R2869	F15	TP803	E16
C2851	E14	C2868	E17	R2858	E13	R2870	C14	TP804	E16
C2852	E14	D2751	D18	R2859	E14	R2871	A15	TP806	A16
C2853	E15	D2751	D9	R2860	E14	R2872	A15	TP895	B15
C2854	E15	D2850	E12	R2861	A17	R2873	B15	V2768	E10
C2856	E15	N2850	B16	R2861	E15	R2875	B15	V2851	E13
C2857	E13	N2850	E16	R2861	E15	R2876	A15	V2852	F15
C2861	A15	R2762	D10	R2862	E15	R2876	A15	V2853	B14
C2862	B15	R2765	D10	R2863	E14	R2877	A16	V2854	B17
C2862	B15	R2776	E9	R2864	E16	R2878	B16		

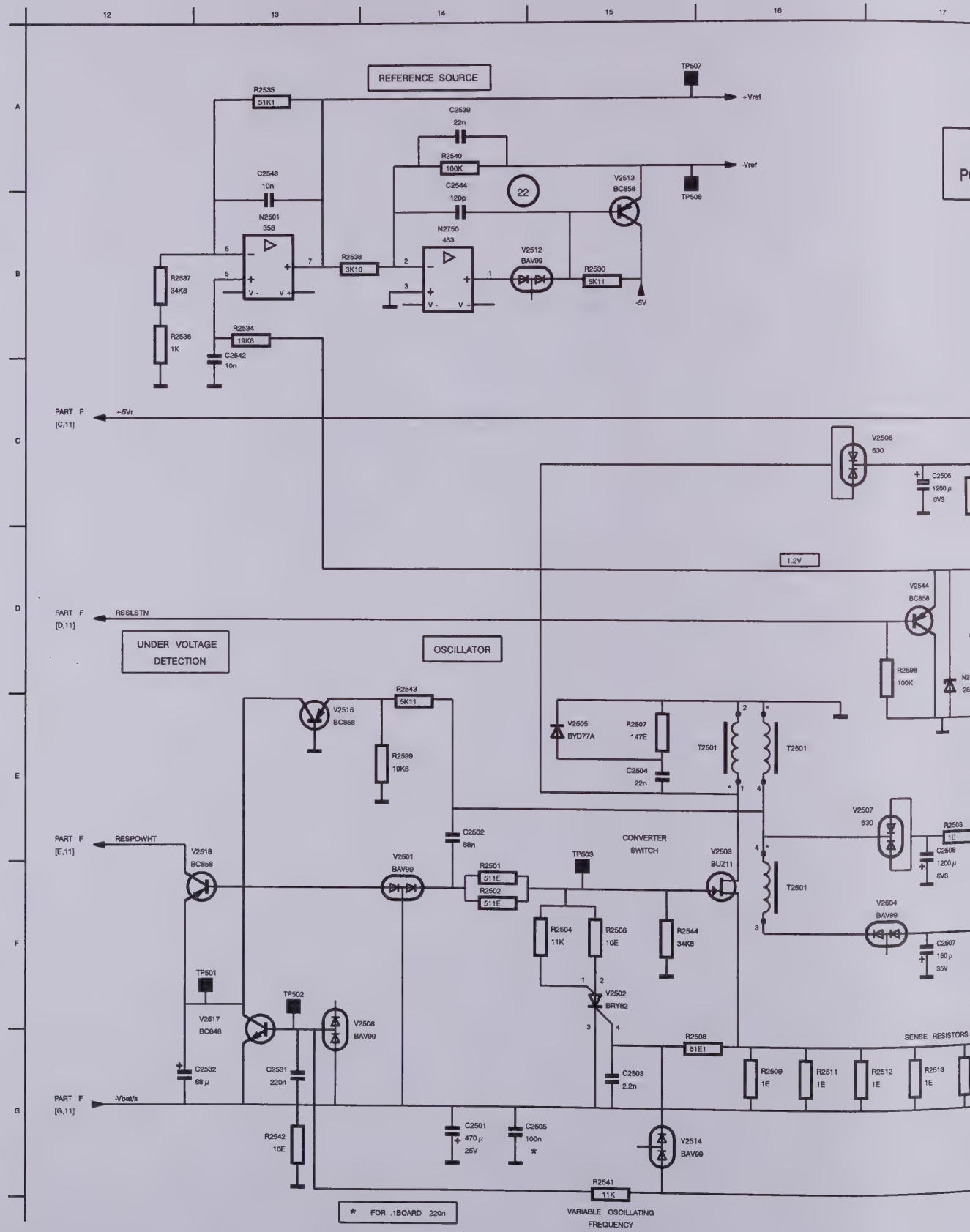
PARTS LOCATION A2 PCB CIRCUITDIAGRAM PART E

C2301	C20	C2319	A27	R2309	E24	R2332	B28	R2359	D26
C2302	C21	C2322	C26	R2310	G26	R2333	B27	R2360	E23
C2303	C24	C2323	C25	R2311	F26	R2334	B28	R2361	E23
C2304	F21	C2324	C25	R2313	E20	R2335	B27	R2362	E23
C2306	C22	C2326	B26	R2315	B23	R2336	B28	R2363	E23
C2307	C22	C2351	C20	R2316	C24	R2337	B27	R2364	D26
C2308	B23	D2302	E21	R2317	B24	R2345	B24	R32302	C21
C2309	E20	E2327	E26	R2319	D26	R2346	B24	TP331	B24
C2310	C24	N2301	E25	R2320	E23	R2347	C24	TP332	B24
C2311	E20	N2301	G25	R2321	G23	R2350	E26	V2304	F22
C2312	E24	N2302	B26	R2322	G23	R2351	E20	V2305	E25
C2313	E23	R2301	C20	R2323	E25	R2352	G26	V2306	D26
C2313	E23	R2303	B25	R2324	E25	R2353	G26	V2307	G26
C2314	C26	R2304	C24	R2325	F25	R2354	G22	X2001	A28
C2315	C27	R2305	F21	R2326	F25	R2355	D26		
C2316	F22	R2306	C21	R2328	D23	R2356	D25		
C2317	A27	R2307	C20	R2330	B28	R2357	E27		
C2318	A26	R2308	C24	R2331	B27	R2358	E27		


ANALOG ASIC
D2302
OQ00259
TP332
TP331
R2315 100E
R2317 100K
C2308 10n
R2346 10K
OFFSET
R2303 1K33
R2345 100K
R2316 100K
R2347 10K
GAIN
C2323 2n2
R2304 511K
C2310 10n
R2308 75K
HF-COMP
C2303 100n
R2301 1E
R2307 1E
R2302 1E
R2308 1E
C2301 100n
C2351 100n
C2302 100n
C2306 100n
C2307 100n
+5Va
-5V
+5V
VE
VCCab
GNDa
VEEa
VCCa
GNDa
VEEa
VCCa
INPB
INPGNDB
INPA
INPGNDA
TRIG
GAIN
VCCt
GNDt
VEEt
SNGOUT
VREF
STOPGND
CLKN
STOP
TOUT
HOLDOF
CHA
LEVEL
CDAT
CCLK
DTAE
VCCc
GNDc
VEEc
CLK
TRACK
PART B [E,24]
ATTB--A
ATTA--A
PART C [C,7]
EXT TRIG
R2351 147K
R2313 1E
C2309 100n
C2311 100n
R2329 100E
STOPO
STOPN
TOUT
R2361 511E
R2363 511E
R2362 3K38
R2360 3K38
HLDOFN
CHANA
R2309 75K
LEVEL
R2320 75K
C2313 22n
C2312 220n
R2324 3K18
R2325 10K
TOP
C2304 100n
C2316 100n
R2305 1E
V2304 BC848
R2354 1K
R2321 ∞
R2322 316K
OPTION
PART A [G,3]
CONTROL-BUS

PARTS LOCATION A2 PCB CIRCUITDIAGRAM PART G

C2501	G14	C2532	G12	R2503	E17	R2534	B13	TP509	D19
C2502	E14	C2539	A14	R2504	F15	R2535	A13	TP511	E18
C2503	G15	C2540	E17	R2506	F15	R2536	B12	V2501	F14
C2504	E15	C2541	E18	R2507	E15	R2537	B12	V2502	F15
C2505	G14	C2542	B13	R2508	G15	R2538	B14	V2503	F16
C2506	C17	C2543	B13	R2509	G16	R2540	A14	V2504	F17
C2507	F17	C2544	B14	R2511	G16	R2541	G15	V2505	E15
C2508	E17	C2546	C19	R2512	G16	R2542	G13	V2506	C16
C2509	D17	C2547	E19	R2513	G17	R2543	E14	V2507	E17
C2511	D19	C2548	E19	R2514	G17	R2544	F15	V2508	F13
C2512	D19	C2549	B21	R2516	G17	R2583	B21	V2509	D20
C2514	E18	C2551	B21	R2517	G18	R2584	E18	V2511	E20
C2514	C19	C2552	C21	R2518	G18	R2584	E18	V2512	B15
C2516	E18	L2501	C18	R2522	D18	R2598	D17	V2513	B15
C2517	C21	L2502	E18	R2523	D18	R2599	E14	V2514	G15
C2518	B21	L2503	C20	R2526	C17	T2501	E16	V2516	E13
C2519	B21	N2501	B13	R2527	D18	T2501	F16	V2517	F13
C2521	E19	N2501	D18	R2528	D19	TP502	F13	V2544	D17
C2522	E19	N2502	D17	R2529	D20	TP503	F15		
C2523	F17	N2750	B14	R2530	B15	TP504	F18		
C2524	C21	R2501	F14	R2531	B21	TP507	A15		
C2531	G13	R2502	F14	R2532	E18	TP508	A15		


REFERENCE SOURCE
TP507
+Vref
-Vref
TP508
R2535
51K1
C2539
22n
R2540
100K
C2543
10n
C2544
120p
22
V2513
BC858
N2501
358
N2750
453
R2538
3K16
V2512
BAV99
R2530
5K11
-5V
R2537
34K8
R2536
1K
R2534
19K6
C2542
10n
PART F
[C,11]
+5Vr
V2506
630
C2506
1200 µ
6V3
1.2V
V2544
BC858
PART F
[D,11]
RSSLSTN
UNDER VOLTAGE
DETECTION
OSCILLATOR
R2543
5K11
V2516
BC858
R2599
19K8
R2598
100K
V2505
BYD77A
R2507
147E
T2501
C2504
22n
C2502
68n
CONVERTER
SWITCH
V2507
630
R2503
1E
C2508
1200 µ
6V3
PART F
[E,11]
RESPOWHT
V2518
BC858
V2501
BAV99
R2501
511E
R2502
511E
TP503
V2503
BUZ11
V2504
BAV99
C2507
180 µ
35V
R2504
11K
R2506
10E
R2544
34K8
TP501
TP502
V2502
BRY82
V2517
BC848
V2508
BAV99
R2508
51E1
SENSE RESISTORS
C2532
68 µ
C2531
220n
C2503
2.2n
R2509
1E
R2511
1E
R2512
1E
R2513
1E
PART F
[G,11]
-Vbat/s
C2501
470 µ
25V
C2505
100n
*
V2514
BAV99
R2542
10E
R2541
11K
* FOR 1BOARD 220n
VARIABLE OSCILLATING
FREQUENCY

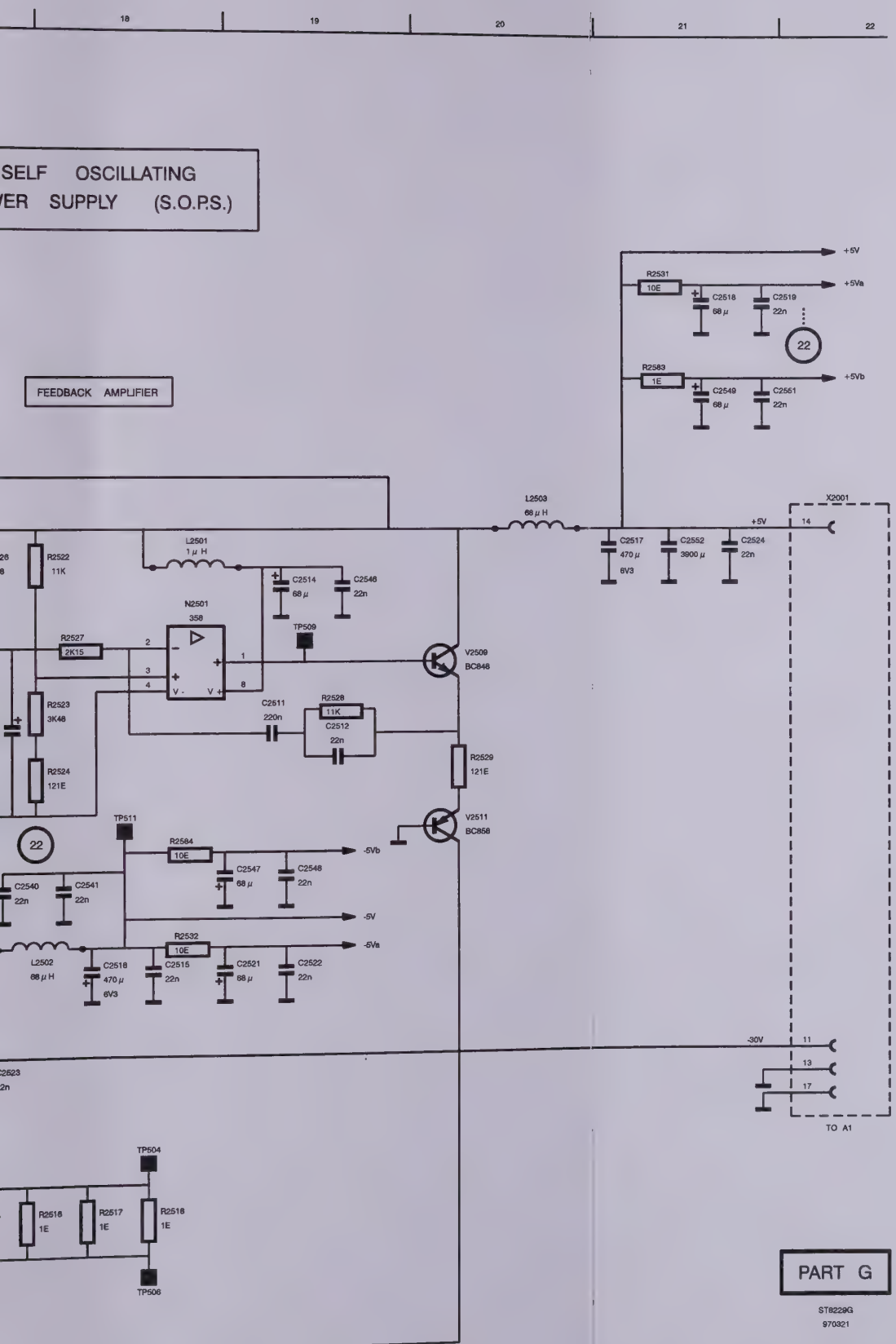


Figure 9.14 Analog A2 PCB circuit diagram (part G)

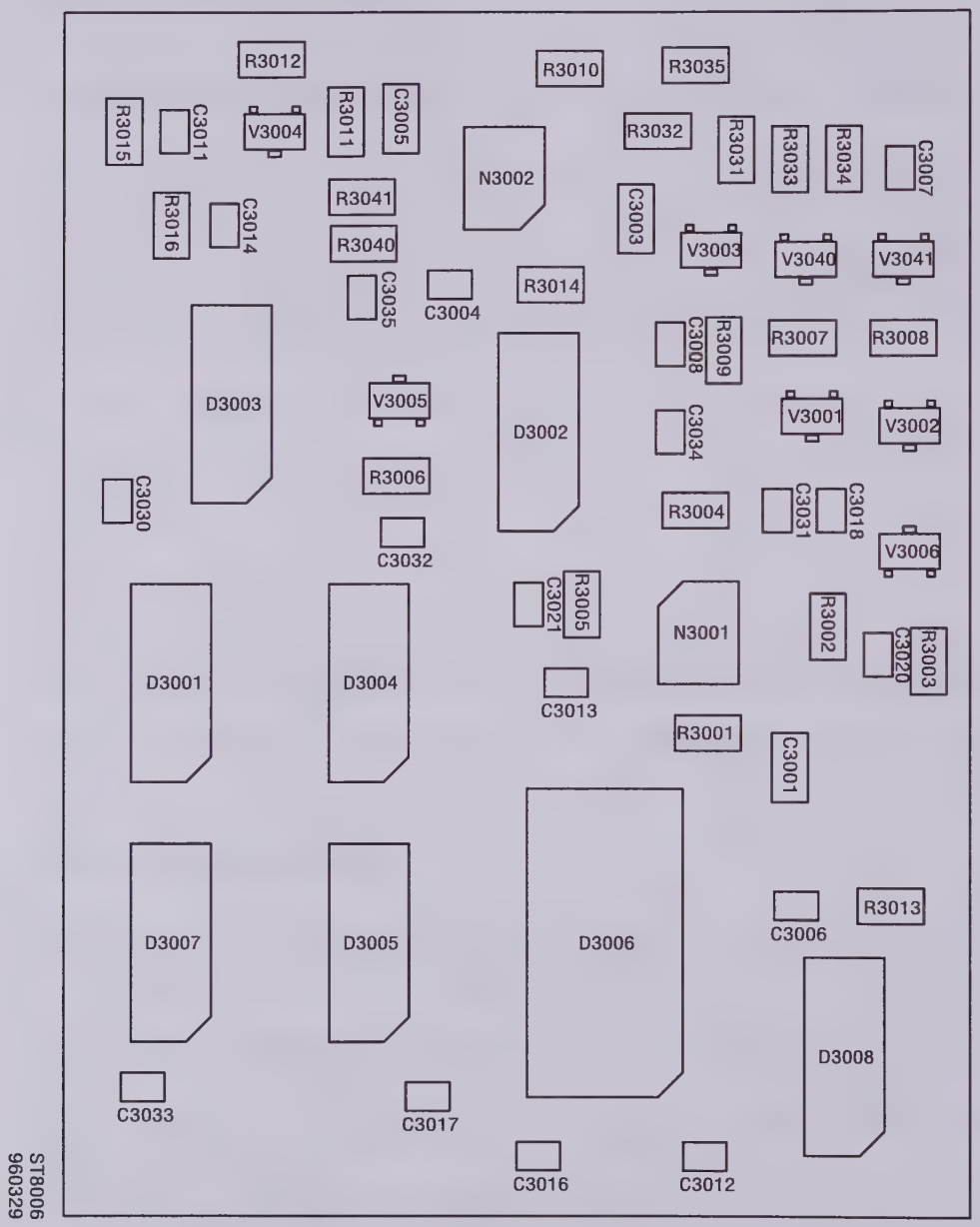


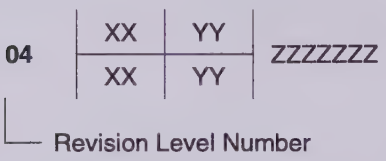
Figure 9.16 TV TRIGGER PCB A3

10 MODIFICATIONS

10.1 HARDWARE MODIFICATIONS, PCB REVISION LEVELS

On PCN's (Product Change Notices), revision levels are used to indicate the PCB status.
The ANALOG BOARD A1 and the DIGITAL BOARD A2 have two stickers on them which identify their revision level. However, one of these stickers is used only in the factory to identify the revision level of a lower assembly. This number on this revision level sticker begins with an "S".
The revision level stickers for complete DIGITAL BOARD A1 and ANALOG BOARD A2 assemblies are located as indicated below. All revision level descriptions refer to the complete DIGITAL BOARD A2 and ANALOG BOARD A1 assembly.

The revision level number is printed on the left hand side of the sticker.



The ANALOG BOARD A1 revision level sticker for the complete assembly is located near input A on the shield that is permanently attached to the board. You must remove the top shield to access it.

The DIGITAL BOARD A2 revision level sticker is located between the two display driver chips D1406 and D1407.

10.2 FIRMWARE VERSIONS

Press function keys F1 and F5 at the same time to display the installed software release. Contact your nearest Service Center for information about upgrading the software.

10.2.1 Hardware modification for firmware V8.60 and newer.

For firmware modification version V8.60 and later A2 must be modified. Also after loading the new firmware the ScopeMeter Test Tool must be calibrated.
Hardware modifications:
1. The value of R2320 has changed from 68k1 to 75 kΩ.
2. R2321 and C2706 have been removed. For the location of these components refer to page 9-13.

Firmware modification and calibration:

1. Verify the firmware revision level and check for the presence of additional language files by pressing the F1 and F5 softkey simultaneously. If the unit has an additional language file, this will be displayed after the English language version.

2. When the unit has an additional language file, load the ***BV860.LDF (or newer version) file and then the appropriate additional language file according to the instructions given in Service Alert SA-1203. Use the latest language file of the list. If the unit has only the English language file no additional firmware load files are required.

Load the ***BV860.LDF file into the unit. Use the Loader Program option:

FIRMWARE : LOAD FROM FILE **CALIBRATION DATA** : DEFAULT

3. Calibrate the instrument.

Do a performance test to ensure that the unit is in tolerance and fully meets specifications

10.3 MODIFICATIONS A1 PCB

10.3.1 MEMORY ENLARGEMENT FOR ASIATIC LANGUAGES

For the Asiatic Languages 5 MB of memory must be installed. The normal versions have 4 MB of memory installed.
Modification for extra memory:
1. Install D1221, P/N 5322 209 52456, on the A1 board. For the correct position, refer to Figure 10.1.
2. Move R1241 to the position of R1240.

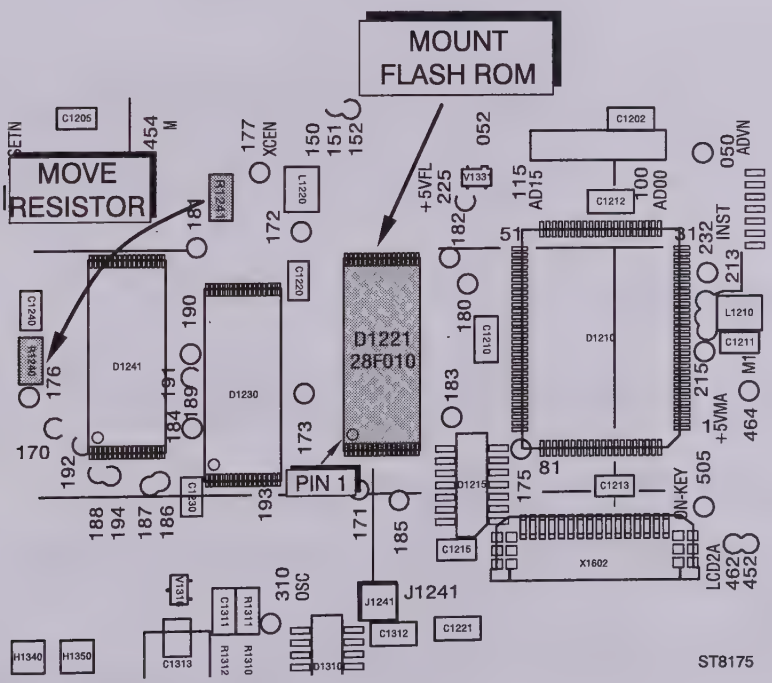


Figure 10.1 Position new components

10.3.2 New drivers for LCD on A1

The LCD drivers D1401, D1402, D1403, D1404, D1405, and D1406 will be replaced by the HD66206TE. The P/N is 5322 209 15912. The P/N for the board did not change. The new board and the old board are interchangeable. See the new diagram and assembly drawing on the next pages.

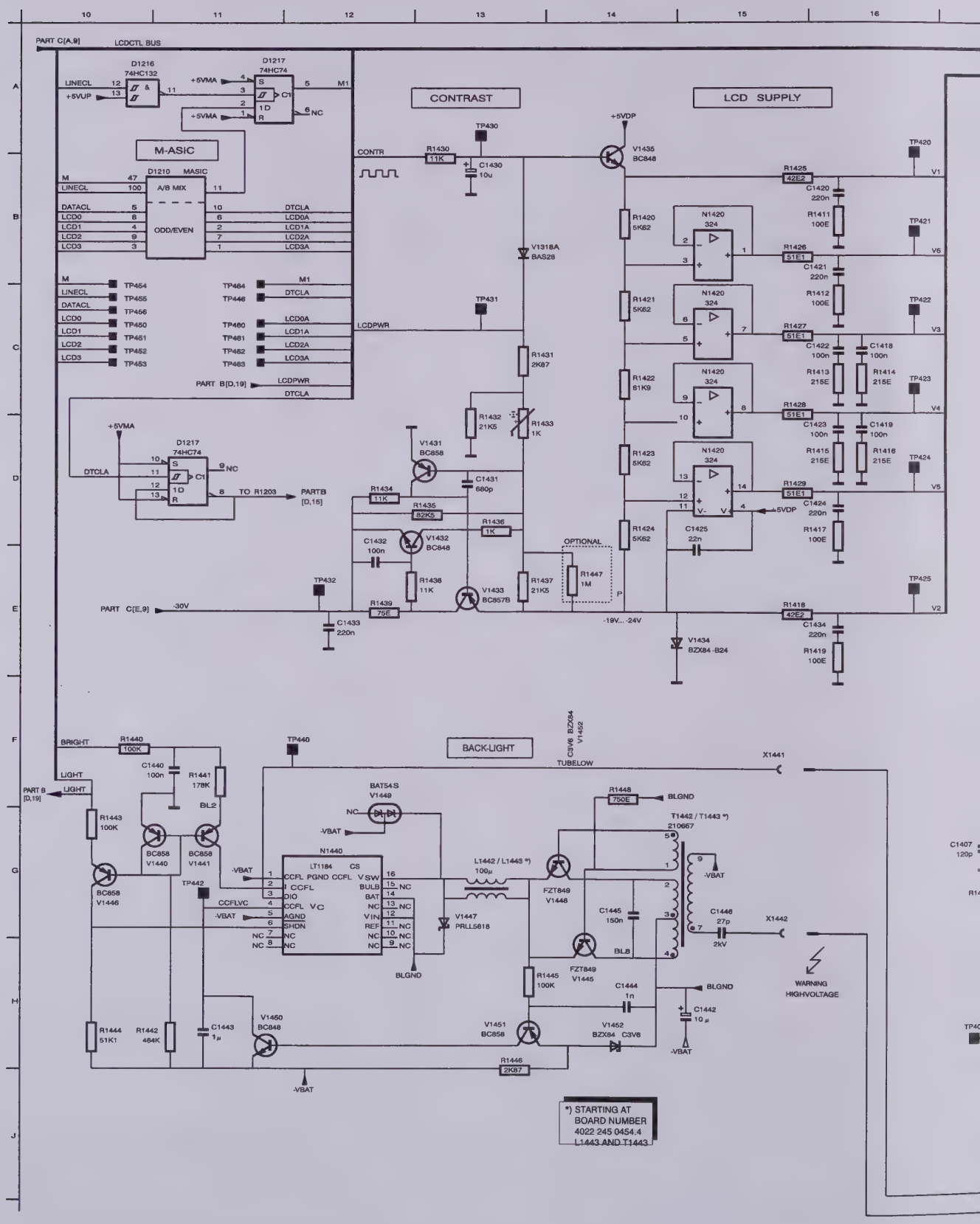
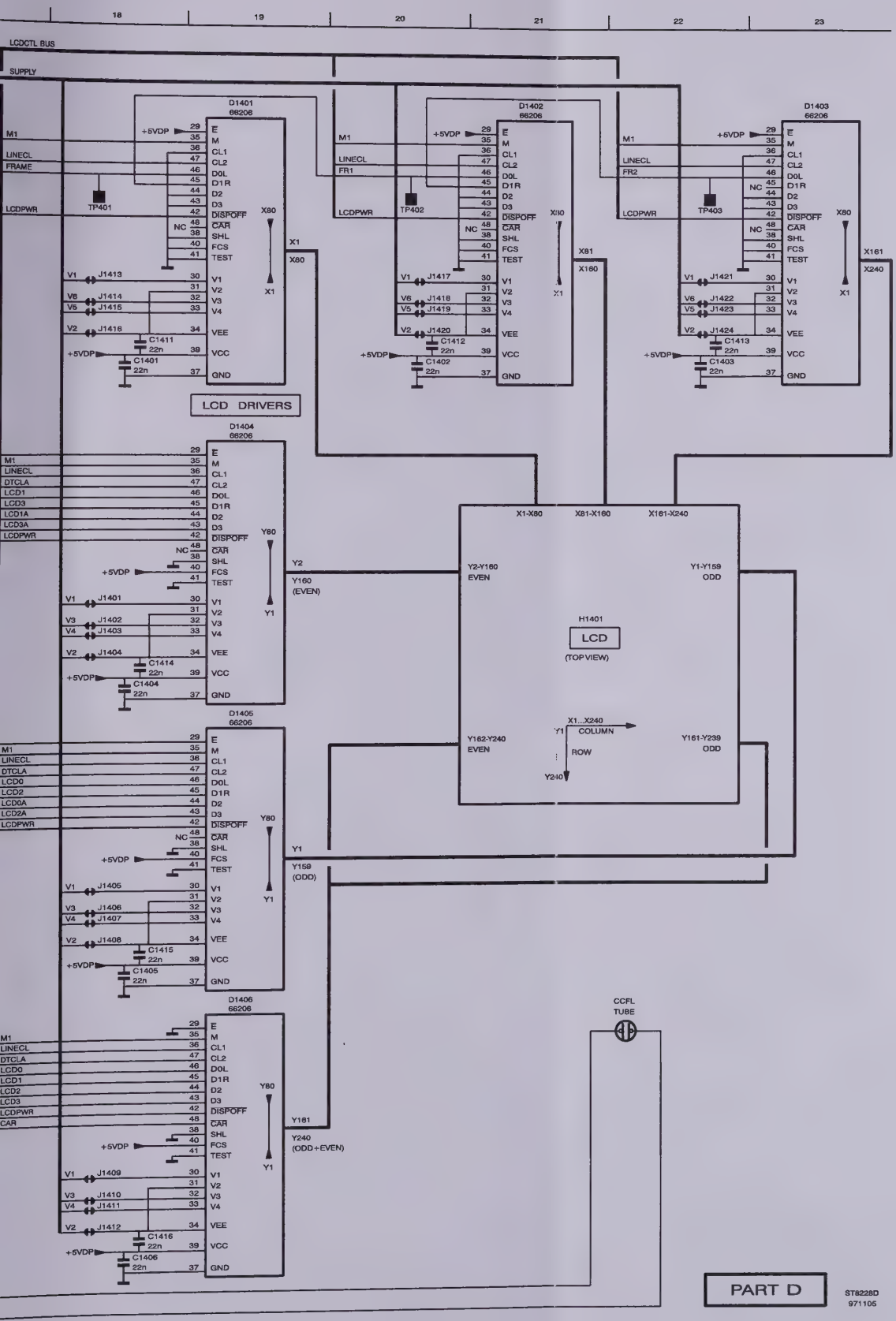


Figure 10.2 Modified part D of the Digital A1 board

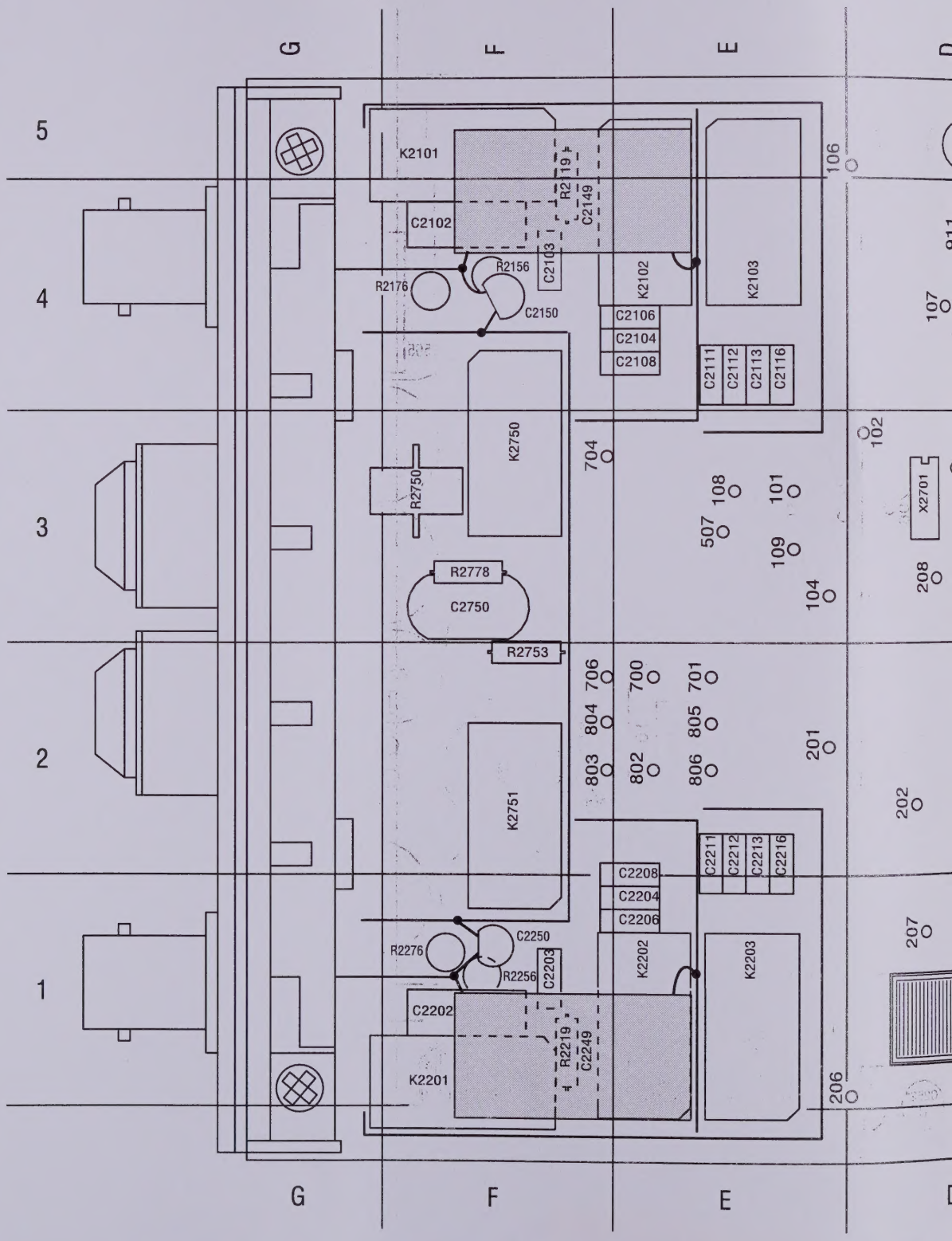

18
19
20
21
22
23
LCDCTL BUS
SUPPLY
D1401
66206
D1402
66206
D1403
66206
+5VDP
M1
LINECL
FRAME
FR1
FR2
LCDPWR
TP401
TP402
TP403
DISPOFF
CAR
SHL
FCS
TEST
NC
X80
X1
X81
X160
X161
X240
V1
V2
V3
V4
V5
V6
VEE
VCC
GND
J1413
J1414
J1415
J1416
J1417
J1418
J1419
J1420
J1421
J1422
J1423
J1424
C1411
C1412
C1413
C1401
C1402
C1403
22n
LCD DRIVERS
D1404
66206
D1405
66206
D1406
66206
DTCLA
LCD1
LCD3
LCD1A
LCD3A
LCD0
LCD2
LCD0A
LCD2A
CAR
Y80
Y1
Y2
Y160
(EVEN)
Y158
(ODD)
Y161
Y240
(ODD+EVEN)
X1-X80
X81-X160
X161-X240
Y2-Y160
EVEN
Y1-Y159
ODD
H1401
LCD
(TOP VIEW)
X1...X240
COLUMN
ROW
Y162-Y240
EVEN
Y161-Y239
ODD
CCFL
TUBE
PART D
ST8228D
971105

10.4 MODIFICATIONS A2 PCB

The A2 PCB is modified to reduce the interference, caused by the power converter, on the ranges 1, 2, and 5 mV. Some ScopeMeter Test Tools can have an old modified board with number 4022 245 0456.**1**.
The boards with number 4022 245 0456.**2** never have been used and the boards with number 4022 245 0456.**3** are the new ones.
Old boards you can still modify according PCN4276.

New parts:

ITEM	DESCRIPTION	ORDERING CODE
C2504	CER CHIP CAP 10% 22 nF (*A-2*)	5322 122 32654
C2505	CER CAP A AVX 100 V 10% 220 nF (board ***.1***, *B-2*)	4822 122 32916
C2505	CER CAP A AVX 100 V 10% 100 nF (board ***.3***, *B-2*)	5322 126 13186
C2525	CER CHIP CAP 63V 10% 100 nF (*B-4*)	4822 122 33496
C2528	CER CAP A AVX 100 V 10% 100 nF (*A-4*)	5322 126 13186
C2535	CER CAP A AVX 100 V 10% 100 nF (*A-4*)	5322 126 13186
L2500	MICRO CHOKE 15 (H (*B-4*)	4822 157 53066
L2505	MICRO CHOKE 15 (H (*B-4*)	4822 157 53066
R2507	RES. CHIP RC-02H 1% 147Ω (*A-2*)	4822 051 51471
V2505	RECT. DIODE BYD77A (soldered on R2507, A-2)	5322 130 10763


G
F
E
5
4
3
2
1
K2101
R2219
C2149
C2102
C2103
R2156
R2176
C2150
K2102
K2103
C2106
C2104
C2108
C2111
C2112
C2113
C2116
106
107
K2750
R2750
704
102
X2701
507
108
101
109
104
208
R2778
C2750
R2753
706
700
701
804
805
803
802
806
201
K2751
202
C2211
C2212
C2213
C2216
C2208
C2204
C2206
207
C2250
R2276
R2256
C2203
K2202
K2203
C2202
R2219
C2249
K2201
206

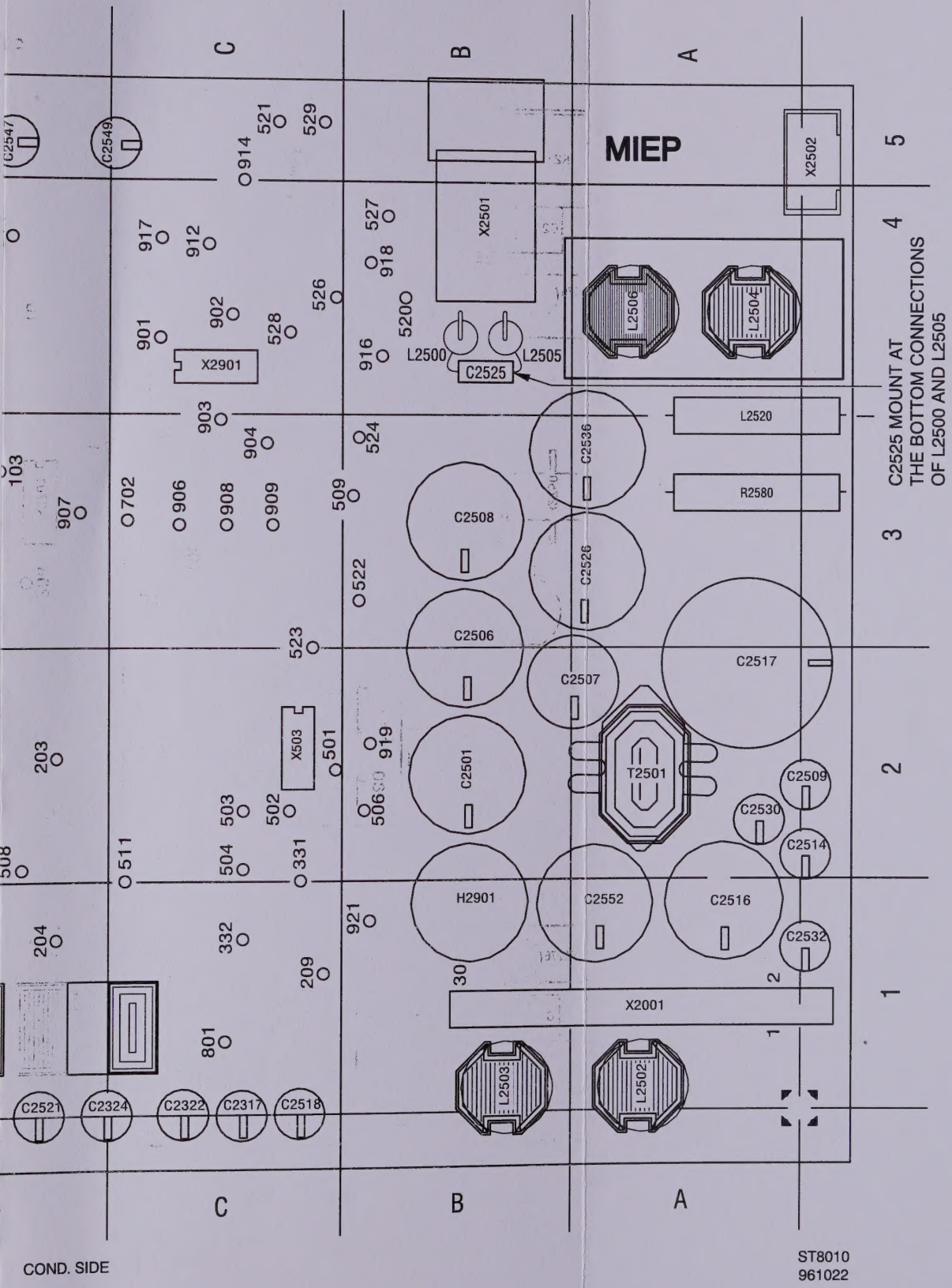


Figure 10.5 ANALOG PCB A2 assembly (wired component side)